TASMANIA

DEPARTMENT OF MINES

GEOLOGICAL SURVEY RECORD

No. 4

# A Monograph of Nototherium Tasmanicum

(Genus—OWEN: Sp. nov.)

BY

H. H. SCOTT

CURATOR OF THE VICTORIA MUSEUM, LAUNCESTON, TASMANIA

Issued under the authority of the Honourable J. E. OGDEN, Minister for Mines

Hobart:

JOHN VAIL, GOVERNMENT PRINTER, TASMANIA

1915

[7s. 6d.]

Esq.

Regards

H H Scott

July 3. 1915

List

NOTOTI

W. E. Burbury. Esq.
with best regards
H H Scott
July 9. 1915

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# ADDENDUM.

List of some Comparative Skull Characters, showing that the Nototherian skull is nearer to that of the Native Bear than it is to the Wombat or the Kangaroo.

| NOTOTHERIUM. | NATIVE BEAR. | WOMBAT | KANGAROO. |
|---|---|---|---|
| Lower tusks operate very directly against lateral incisors. (P.) | Operate exactly as in the Nototherium. | No lateral incisors present in skull, lower tusks act directly against the upper tusks. | Operate against incisors by a method peculiar to the needs of the animal, not quite as in Nototherium. |
| Palate and basi-cranial axis up-turned to a maximum degree among mammals. (P.) | Palate much up-turned, and axis slightly so. | Palate very slightly up-turned, axis normal (as among mammals generally). | Palate and basi-cranial axis bent downwards |
| Enormous pre-masseter process of the zygoma largely compounded out of the zygomatic process of the maxillary—direction—downwards and backwards. (K.) | Process present as a part of the zygoma, but less distinct than in Kangaroo. | No process present. | Process present, very distinct, direction—downwards and backwards. |
| An incipient supra-orbital process well removed from the lachrymal. Lachrmyal missing in our specimen. (W.) | Very strong process, also a small lachrymal ditto, former removed from the latter. | Incipient process and a lachrymal process, former well removed from the latter. | A combined lachrymal and frontal process. |
| Zygomatic process of the Squamosal forming a vertical face of bone. (P. & K.) | Practically the same as of the Nototherium and Kangaroo. | Process turned to the angle of 45%, tending to form a platform rather than a wall. | Process vertical, agrees with Native Bear and Nototherium more than the Wombat |
| Par-occipital processes thick and massive, of fair length, removed from the rim of the occiput, which latter is mastoid in origin, but does not form a process. (W.) | Par-occipitals long and slender, no mastoid process, former practically forming the rim of the occiput. | Par-occipitals more like those of Nototherium, removed from rim of occiput, which is largely formed by a strong mastoid process. | Par-occipitals long and slender, mastoid forming a process, which actually rims the occiput. |
| Occiput wide and slanting upwards, supra-occipital cutting into regions of the parietals all traces of inter-parietals gone. (W.) | Occiput narrow and arcuate, inter-parietal forming a moiety of the calvarium. | Occiput wide, no interparietal on the calvarium centrally depressed as in Nototherium. | Occiput more allied to Native Bear than either Wombat or Nototherium. |
| Auditary meatus not formed by a distinct bony ring. Bullæ apparently were large and inflated. (P.) | As with Nototherium exactly. Bullæ large cone-shaped inflated bodies. | Auditory meatus a loose bony ring, never strongly anchylosed to the skull, quite unlike Nototherium and Native Bear. | Auditory meatus a very distinct bony ring, not so loose as in Wombat, simulating the ungulates. |
| Incipient parietal Crest. (P.) | Small parietal crest. | No parietal crest. | No parietal crest. |
| Widest part of the skull at pre-masseter regions. (P.) | Widest part of the skull at orbital regions. | Widest part of the skull at glenoid regions. | Widest part of the skull at glenoid regions. |
| Ratio of height of skull and manible to length as 21 is to 34. (P.) | Ratio of height to length as 20 is to 35. | Ratio of height to length as 25 is to 41. | Ratio of height to length as 18 is to 38. |
| Ratio of width of skull to its length is as 3 is to 4. (P.) | Ratio of width to length is as $2\frac{1}{2}$ is to 4. | Ratio of width to length is as 3 is to 5. | Ratio of width to length is as $2\frac{1}{2}$ is to 5. |

NOTE.—(P.), signifies Phascolarctus (Native Bear). (K.), Kangaroo. (W.), Wombat. All combinations of letters equal compound affinities.

The result is, that out of twelve important skull characters (eight of which assist in the determination of the outline of the head), seven bring the Native Bear and Nototherium directly together to the exclusion of the other skulls. Once the Kangaroo and Native Bear agree with the Nototherium to the exclusion of the Wombat. Once the Kangaroo and Nototherium agree to the exclusion of the other two. Three times the Wombat agrees with the Nototherium to the exclusion of the other two skulls. The ear of the Nototherium and Phascolarctus practically the same, and must have been of similar appearance in life.

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# Author's Preface.

THIS monograph owes its publication to the thoughtfulness of the Hon. J. E. Ogden, Minister for Mines, who has arranged for it to be issued in connection with the Geological Survey of Tasmania. This assistance has enabled the facts deduced from a study of the most complete *Nototherian* skeleton yet recovered to be made public.

My personal thanks are due to Dr. E. C. Stirling, F.R.S., who has given much practical help and encouragement, and who kindly brought under my notice the photograph of the Buchan Cave femur.

To Professor T. W. Edgeworth David, C.M.G., I am indebted for much sound advice, particularly in the early days of my investigations. At inconvenience to himself he edited my rough notes, and presented them to the Australasian Association for the Advancement of Science at its meeting in Melbourne in 1913. His valued criticisms, always available, have been utilised in numerous ways.

The photographs in this monograph are the work of Messrs. Burrows and Co., Launceston, and the conjectural restoration sketch has been executed by Mr. Victor Henry.

H. H. SCOTT.

Victoria Museum, Launceston,
26th January, 1915.

# Introduction.

A SHORT description of *Nototherium tasmanicum* was given by me in the "Tasmanian Naturalist" for April, 1911, an account of the locality in which the remains were discovered being supplied by my collaborator, Mr. K. M. Harrisson. As originally described, the species depended upon the departures made by the humerus from the similar bone relegated by Professor Owen to his species *N. mitchelli*, as also on the greater extent of the mandibular symphysis and the shorter tooth-line. In November in the same year Dr. Fritz Noetling, M.A.,(1) contributed a paper to the Proceedings of the Royal Society of Tasmania on the taxonomic position of the species. In August, 1912, I published in the Victoria Museum series of memoirs (No. 4) some additional notes with three half-tone illustrations. In that brochure I advanced reasons for the restoration of Professor Owen's *Nototherium victoriæ* to a higher rank than that of a mere individual variation of *Nototherium mitchelli*, as remains of a precisely similar animal had reached me from King Island. In the present monograph I have collected the substance of the above publications and added a fairly exhaustive analysis of the skeleton as a whole. The personal conviction reached at the end of my studies is that the humerus and femur hitherto accepted on the high authority of Professor Owen as being those of *N. mitchelli* really belong to some phascolomyoid animal of the character of *Phascolonus gigas*. The extinct wombat of King Island, however, departs from the mainland form with regard to its humerus similarly to *N. mitchelli* and *N. tasmanicum*, and therefore it may yet be proved that Professor Owen was right. In the present state of uncertainty in respect of the appendicular skeleton of *N. mitchelli* the taxonomy of the *Nototheria* must be considered as unsettled. Workers in the field of marsupial palæontology have now, however, a court of appeal in a nearly complete skeleton of a *Nototherium* which is at present exhibited in the Victoria Museum, Launceston. In this skeleton each bone is an absolute associate of the rest, not a single fragment being culled from a second individual. The remains of the *Nototherium* from King Island are also shown for comparison.

With the exception of some remains found on Kangaroo Island, awaiting description by Dr. Stirling, the specimens dealt with in this monograph are the only indications yet known of the existence of these animals off the present mainland of Australia.

(1) "The Occurrence of Gigantic Marsupials in Tasmania": Fritz Noetling, M.A., Ph.D. Pro. Roy. Soc. Tasmania. November 14, 1911.

# Conspectus.

The taxonomic positions of the two forms referred to in the present text are as follows :—

(1)

| | |
|---|---|
| Order ..... | *Marsupialia* |
| Family ..... | *Nototheriidæ* |
| Genus ..... | *Nototherium* (Owen) |
| Species ..... | *Tasmanicum* (sp. nov.) |

(2)

| | |
|---|---|
| Order ..... | *Marsupialia* |
| Family ..... | *Nototheriidæ* |
| Genus ..... | *Nototherium* |
| Species ..... | *Victoriæ* (Owen) ([1a]) |

*Range of the Above as Far as at Present Known.*

No. 1. Tasmania.

No. 2. South Australia and King Island; Western Australia; (Queensland; and perhaps New South Wales?).

All extinct.

([1a]) This is now suspected to be a female animal, sp. ind., and most likely a synonym of *Zygomaturus* as reconstructed by De Vis.

# Discovery and General Description.

The present remains of *Nototherium tasmanicum* were found in July, 1910, by Mr. E. C. Lovell, while cutting a drain through Mowbray Swamp, about 3 miles from the town of Smithton, in North-Western Tasmania. This swamp is about 55 feet above sea-level and 3 miles inland.

Dr. Fritz Noetling, M.A., in a paper on "Gigantic Marsupials in Tasmania" (Pro. Roy. Soc. Tas. for 1911), discusses the age of the beds in the Mowbray Swamp, and concludes that "they are of quite a recent age; in other words, that the gigantic marsupials must have lived in Tasmania up to quite recent times." Mr. F. Chapman, Palæontologist to the National Museum, Melbourne, in his "Notes on Testacea from the Pleistocene Marl of Mowbray Swamp, North-West Tasmania" (Memoirs of the National Museum, Melbourne, No. 5, 1914), is of the opinion that the remains of *Nototherium* found in this swamp cannot date very far back in Pleistocene times. As far as the available evidence admits of a conclusion, the probability is that the beds are of late Pleistocene age.

In his paper in the "Tasmanian Naturalist" referred to above Mr. Harrisson describes fully the locality and the circumstances of the discovery. *Inter alia*, he says :

> "The bones were in a rather wet portion of the swamp, and although they all appeared to be at the same level, and were lying together, some of the back bones were in front of the head and some of the bones of the fore-leg were behind it, as though they had been slightly scattered by some preying animal."

In extension of this hypothesis I suggested that the loss of the smaller bones of the hands and feet may be due to the same cause, although, of course, water may have been a factor in their removal.

In my former publications I suggested that the specimen used as the type may have been a female, as the shaft of the femur of a calf was found associated with the remains. While throwing out this hint, I qualified it with the caution that it must not be pushed too far. An extended study of the specimen has since led me to believe that the animal was a male, and various remarks bearing on this point will be found scattered through the present text.

Mr. Harrisson has obtained a second specimen of an immature femoral shaft of a *Nototherium* from another part of the Smithton Swamp. This bone is larger than the corresponding bone of our calf, but apparently only about one-third grown. It is of interest to note that all the Smithton *Nototherian* femora thus

known have similar shaft outlines, and conform to a common type in all stages of growth, while they depart *in toto* from Professor Owen's humerus of *Nototherium mitchelli*.

The second *Nototherium* referred to *supra* was recovered from swamp land on King Island. This swamp had for two years been undergoing drainage, and while cutting an open drain the bones were brought to light. Although worthy of separate description I have decided to use them comparatively, as they are more mutilated than those from Smithton, and much fewer in number. The skull is devoid of the whole of the cranial portions, being represented only by the maxillary moieties and the teeth. The latter include the upper and lower series (not quite but almost complete), and most of them *in situ*. As with the Smithton bones, so here, evidence of mutilation prior to inclusion in the matrix is manifest. All the bones show signs of forceful treatment, and the broken remains of the ribs are full of cracks, which have since been filled up with the material of the matrix. One tooth has been torn from its alveolus, and its crown turned upside down upon the floor of the palate and there cemented to the bone by lime and oxide of iron. The preservation of these bones is very uneven, some being chalky and imperfect, while others show scraps of well-preserved bone tissue. It must be admitted that on the whole the cause of these early mutilations of the bones is still a mystery. Some of them look as if caused by long exposure to sun and frost; others, however, suggest violent usage, although no tooth-marks of predaceous carnivora are present.

The discoverer of these remains from King Island was Mr. F. H. Stephenson, to whom the Museum is indebted for the acquisition of the specimens.

At this point it will be convenient to recapitulate the admitted species of *Nototherium*, as it directly assists the consideration of the subject in hand. Three distinct species have been described by Professor Owen, viz.—

*Nototherium mitchelli*,
*Nototherium inerme*, and
*Nototherium victoriæ*,

all three of which were merged into the type *mitchelli* by Lydekker in his "Catalogue of Fossil Mammalia in the British Museum."(2) The elimination of the species "*inerme*" from the list was largely due to the researches of Professor Flower, who claimed that the specimen upon which the species was founded was a mutilated mandible broken down so as to obliterate the alveoli of the tusks.(3) I would only add that the sex of the animal in question was possibly female, as there are reasons for suspecting that both upper and lower tusks in the females were less deeply rooted than in the males.

(2) "Catalogue of Fossil Mammalia in the British Museum," Vol. 5, page 162.
(3) Cat. Ost. Roy. Coll. of Surgeons, page 732

Lydekker's rejection of the species "*victoriæ*" was based upon the ground that the characters relied upon by Professor Owen were purely individual ones. If this were so, the chances against the discovery of another specimen which should also manifest these characters are enormous, yet the animal recovered from the King Island swamp reproduces typically the very characters upon which Professor Owen founded his species. In the light of this second discovery it is obvious that either *N. victoriæ* was a good and true species or else we are here dealing with the characters which determine sex. Until I have presented the whole of my osteological evidence I cannot expand fully this part of the subject, but must content myself with the statement that the *Nototherium victoriæ* of Owen was certainly not a mere individual variation of the type species "*mitchelli*."

A fourth species of *Nototherium*—*N. dunense*—was established by De Vis.(4) This was accepted by Jack and Etheridge in their "Palæontology of Queensland," which volume, however, was of a later date than Lydekker's "Catalogue," and therefore is not dealt with in that work. A humerus, however, described by the same palæontologist in 1883 (5) is stated by Lydekker to be referable to *Diprotodon*, and not to *Nototherium*.(6)

The only remaining species is *Nototherium tasmanicum*, which forms the subject of the present text. I must add, however, that in the Records of the Western Australian Museum (Vol. 1, Part II.) L. Glauert, F.G.S., gives an instructive analysis of two *Nototherian* teeth, and while suggesting specific distinction, leaves the matter open for settlement by future discoveries. This subject will be reverted to later under the heading of "Teeth."

(4) Pro. Linn. Soc. New South Wales, 1887, Part 4, page 1065; also in Pro. Roy. Soc. Queensland, Vol. 5, Part 3, page 116.

(5) Pro. Linn. Soc. New South Wales, 1883, Part 3, page 104.

(6) "Catalogue of Fossil Mammalia in the British Museum," Vol. 5, page 161.

# The Skull and Dentition.

As Professor Owen published such an extensive analysis of the skull characters of *Nototherium mitchelli*(7) a repetition is unnecessary; nevertheless it is needful to call attention to various osteological data culled during the study of our specimen.

The professor's recapitulative description is to the effect that "the skull of *Nototherium* is shorter in proportion to its depth and width than that of the *Diprotodon*, and differs from the latter in the way in which the facial portion is bent up upon the cranial portion and in the angle made by the palate with the basis cranii." He also states that "the *Nototherium* surpasses the *Diprotodon* in absolute and relative size of the zygomatic arches."

The first of these statements was made in the belief that the skull of the *Diprotodon* which had been restored from fragments was correctly outlined, but it has since been stated that the restoration was 4 inches too long. Dr. Stirling, in his recent memoir on the *Phascolonus* (see footnote, *ante*), says that any descriptions based on existing specimens would certainly be incomplete, and that a perfect skull is still a desideratum. Such being the case, direct comparison with *Diprotodon* is at present impossible. The rest of the professor's remarks are absolutely correct.

As will be seen by a glance at Plate 1, the skull is very massive, the zygomatic arches standing away from the cranium to a distance of 150 mm., and, armed with pre-masseter attachment processes, make the skull extremely powerful in this region, and constitute one of its chief characteristics. The maxillo-nasal part of the skull is sharply bent up upon the cranium, the fronto-nasal suture being ankylosed to extinction. The nasals are wide, and completely roof over the nasal cavity, the maxillary moieties being restricted to the outer edges instead of contributing to the roof of the cavity as in the wombat. As thus constituted, these maxillary moieties form two bony processes standing out from the face-line at an angle of 60 degrees. The pre-orbital foramen is nearly round instead of being cuneiform, as in the wombat, its size suggesting a short trunk or movable snout during life. The mandibular dental foramen is much lower down than obtains in the skulls of wombats. In life during normal occlusion the lower tusks operated against the small incisors of the upper jaw, as in the existing native bear (*Phascolarctus*).

(7) "Extinct Mammals of Australia," 1877, Plates XXXVI. and XXXVII.; also Quarterly Journ. Geol. Soc., Vol. 15—Plate VII.

The question of individual variation in the skulls of wombats, native bears, and, indeed, most marsupials, still awaits the attention of an osteologist who can collect an extensive series of specimens, the ages of which can be accurately determined upon a common standard. The fortuitous acquisition of a small series of specimens by one worker (however carefully they may be considered) does not always bring them into line with the deductions of a second investigator at work upon a second such series, the result being that their individual tables are less capable of being blended homogeneously together than would be the data of a single comprehensive table which have passed through the crucible of a single mind. The most valuable and extensive table yet published is that of Professor Baldwin Spencer and J. Kershaw, in Memoir No. 3 of the Melbourne National Museum series, in which the skulls of fifteen wombats of the mainland and thirteen of the Tasmanian form are reviewed. This great advance on all existing tables will continue to be accepted as the standard of age-variation until an even larger one can be constructed, which is certainly a desideratum as regards insular species. In establishing a new species of *Nototherium*, unless skull-variation is correlated with similar variation in the appendicular skeleton, the evidence will lose much of its weight. Accordingly, in my previously published notes on *Nototherium tasmanicum* I paid more attention to the humerus and femur than to the skull—upon the assumption that what applied to the modern wombats might also have held good with the extinct *Nototheria*.

To bring the present notes, however, more or less into line with accepted methods, and also as being germane to the subject generally, hereunder is introduced a comparative table of skull measurements for the type species of *Nototherium* and the species *tasmanicum*. No basi-facial or facial axes can be established, as the basi-occipital bone is the only part of the cranium available in this connection in the case of *N. tasmanicum*. The table, therefore, is simply one of direct, comparative, numerical data. It may be mentioned here that any discrepancy between these measurements and some of those given in my previous publication are attributable to the original skull measurements having been made through the glass wall of the case, hermetically sealed to avoid the crumbling of the bones during their treatment: the object was mainly to illustrate the very considerable increase in size of the new species over that of the type of the genus. The length of the skull in totality was taken from the occipital plate to the tips of the tusks (owing to its position in the case), but a glance at the illustration of the skull (Plate 1) will show that the par-occipitals are thus excluded from the result. The present measurement has been made between two vertical rods, and is not only accurate, but also permits of a direct comparison with the type (cast) which was measured in a similar way.[8]

[8] From a cast in the Tasmanian Museum, Hobart.

*Comparison of Skulls of Nototheria.*

| | Nototherium mitchelli. | Nototherium tasmanicum. |
|---|---|---|
| | mm. | mm. |
| Total length between two vertical rods ... ... ... ... ... | 465 | 551 |
| Total width ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 405 | 430 |
| Zygomatic arches to skull-wall ... ... ... ... ... ... ... | 105 | 150 |
| From naso-frontal suture to tip of the nasals ... ... ... | 168 | 210 |
| Width of nasals ... ... ... ... ... ... ... ... ... ... ... ... ... | 156 | 138 |
| Width in occipital regions ... ... ... ... ... ... ... ... ... | 330 | 336 |
| Par-occipital progress to supra-occipital ridge ... ... ... | 175 | 207 |
| Supra-occipital ridge to frontal pit ... ... ... ... ... ... | 185 | 190 |
| Top of nasals to ends of tusks ... ... ... ... ... ... ... | 169 | 200 |

These data supply us with a skull 16·4 per cent. longer than the type, and show a proportional increase in the nasal region of 5·21 per cent. In nasal width, however, the type exceeds *N. tasmanicum* by 11·5 per cent. If we apply this nasal test to the common Australian wombat (*P. mitchelli*) and the hairy-nosed wombat (*P. latifrons*), both good and true species, we find the nasal variation to be equal to 4·6 per cent. This subject of variation was considered by Messrs. Spencer and Kershaw (9) in their study of the existing wombats, and they decided that it was an inconstant character to which an extreme value could not be attached. Still the comparison is interesting, and, taken in conjunction with other variations of the two skeletons, assists in establishing an amount of departure from a common standard equal to that prevailing among existing specifically distinct wombats. With a view to assist the mind to grasp readily such an amount of skull-variation, comparative outlines are given of the skulls of *Nototherium mitchelli* and *N. tasmanicum* (see Plate 22).

Before passing to the consideration of the mandible, attention is invited to a point relating to the exposed areas of the upper tusks and incisors. These teeth are exposed for a long distance between the alveoli and the stained zone which marks the actual gum-line in life. This pre-alveolar extension, taken in conjunction with the enormous size of the pre-orbital foramen, indicates an exceedingly heavy and fleshy lip or short tapir-like trunk. Nothing akin to this is found in the modern wombats, and it is entirely distinct from mere gum-absorption due to age—if such a character is possessed at all by animals in a state of nature.(10)

(9) Memoirs of the National Museum, Melbourne: No. 3, February, 1910, page 56.

(10) Dr. Ray McClinton (D.D.S. of the University of California) informs me that gum-recession, though not unknown among domesticated animals, is very rare with them. Having examined our *Nototherium*, he is convinced that neither gum-recession nor alveolar absorption is shown in the slightest degree.

*Table.*

| | mm. |
|---|---|
| Right upper tusk from alveolus to gum-line ..... | 35 |
| Ditto second incisor ..... | 12 |
| Ditto third incisor ..... | 15 |

Naturally the exposable tusk area is not included in the above set of measurements. The shape of the skull in the nasal regions would supply ample lodgment for sufficient ringentes-like muscles to govern such a trunk if it existed.

## The Mandible and General Remarks on the Teeth.

Although somewhat shattered, the lower jaws of our specimen are fairly complete. On the left side the ramus was snapped across, but the detached portion is in a state of perfect preservation. The photograph illustrating the mandible, as used in my paper in the "Tasmanian Naturalist," was taken before any restorations were made, and included, not the detached, but only the available parts. This photograph is reproduced (Plate 2) to illustrate the length of the symphysis, and to show the four molars and the pre-molar *in situ*. The damaged coronoid regions can be largely outlined with the actual fragments of bone upon the right side, while the posterior half of the left ramus is absolutely complete, the fracture which separated it being obviously due to hasty torsion of the coronoid while the mandible was still firmly wedged in the matrix.

Thus one complete tooth-line and one perfect coronoid moiety are available for study (excepting the tusks, which have been restored from scraps and partly by "compo"). The two upper tusks are naturally outlined, and are therefore beyond criticism. To recapitulate, the results are as follows:—

*Complete Dentition of Nototherium.*

$$1\tfrac{3}{1}\ C\tfrac{0}{0}\ PM\tfrac{1}{1}\ M\tfrac{4}{4}\ (\times 2)$$

Of these teeth the only ones missing from our specimen are the two pre-molars upon the left side; sundry lower tusks are mutilated; all the rest are present.

The symphysis of *N. tasmanicum* is of much greater extent than that of "*mitchelli*," being in the proportion of 80 to 65. The jaws are longer, and slightly wider, with a dental canal proportionately farther removed from the tooth-line. The tooth-line itself, instead of being longer, as might have been expected, is shorter, in the ratio of 77 to 94.

In his great work upon "The Extinct Mammals of Australia," Professor Owen details the character of the mandibular symphysis, as found in the British Museum specimen, No. 43,088, and remarks (page 260, *loc. cit.*): "The symphysis is in a ver-

tical parallel with the back lobe of the third molar (M No. 1) but not quite extending to the interspace between its socket and that of the fourth molar (M 2)."([11]) In *N. tasmanicum* it reaches to the middle of the next tooth. With the exception of one measurement of depth, I refrain from giving such data for various parts of the ramus, as the upturning of the alveolar ridges makes it possible to vary the results. In the modern wombat the mandible shows the bony substance surrounding the roots of the incisor teeth to be so compressed as to exactly fit the finger and thumb, seeming, in fact, to have been moulded out of plastic materials, which, under the compression, formed two bony ridges raised slightly above the floor of the median plane of the symphysis. In the present specimen a similar result is noted, the ridges being raised to 10 mm., and arched inwards, thus forming, with the floor of the diastema, a tube three-fourths completed with bone.

*Comparative Measurements.*

| | N. mitchelli. | N. tasmanicum. |
|---|---|---|
| | mm. | mm |
| Length of the symphysis ... ... ... ... ... ... ... ... ... ... | 130 | 160 |
| Antero-posterior length of the tooth-line (actual grinding surface) ... ... ... ... ... ... ... ... ... ... ... ... ... | 188 | 155 |
| Width of mandible anterior to coronoid process ... ... | 194 | 203 |
| From back of last molar to entry of dental canal ... ... | 68 | 83 |
| Thickness of mandible below molar 2 (Owen) ... ... ... | 62 | 54 |

From *Nototherium victoriæ* the mandible of *N. tasmanicum* differs in the greater width of the coronoid regions; in the ascending process, sloping backwards to a greater degree than Owen's figure ("Extinct Mammals of Australia," Plate 41, Figs. 1 and 2); and in the orifice of the dental canal, being raised 25 mm. above the alveolar border, and therefore approximately on a level with the crown of molar No. 4 in its present state. It also differs in the regions of the symphysis. For the proof of mandibular departures from Owen's types compare his figures with Plate 3 of the present text.

Our copy of the British Museum catalogue of fossil mammals was used by Mr. Richard Lydekker in checking the collection, and contains many pencil notes in the margin. Against the cast of the restored skull (No. 33259) is written: "The right pre-molar is much larger than the left, and probably did not belong to it." As the pre-molar has had an eventful history in the *Marsupialia* it is unfortunate that the left side of the skull is devoid of these teeth in our specimen.

([11]) Professor Owen's figure also agrees exactly with his descriptive note upon the extent of the symphysis.

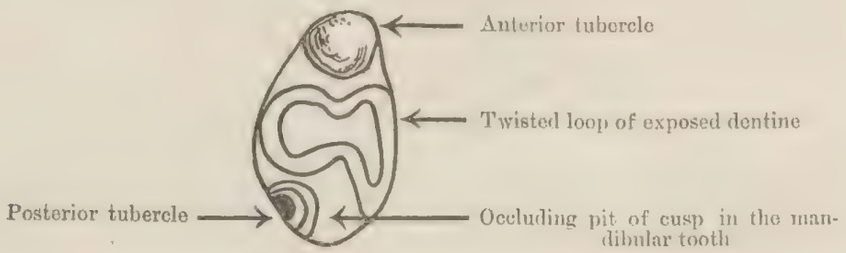
The anterior fang of the left mandibular pre-molar is, however, *in situ*, and the first molar is unmutilated, so that it is possible to say that the two teeth of the mandible could not have varied in an anterio-posterior direction to an extent greater than 1 mm. Hereunder is an analysis of the teeth. Accompanying this analysis are some correlative notes on the second species—*Nototherium victoriæ*. These several teeth are *in situ*; as the remains of the first species were obtained from bog land, and those of the second species are heavily ironstained, no confusion could arise even if both sets were removed from their alveoli and mixed together.

As already remarked, both upper tusks of *N. tasmanicum* are complete in respect of length and girth, the lower ones being mutilated, and the right-hand one was restored for exhibition purposes. All four tusks of *N. victoriæ* are present (the lower ones being *in situ* in a fragment of the ramus), although their actual cutting surfaces are missing. The upper tusks of this latter animal are also minus the grinding surfaces, and in total length do not exceed 90 mm. From the character of the curve described by these tusks it would appear that we are dealing with a shorter-nosed animal than *N. tasmanicum*; the emergent arc of the teeth on leaving their alveoli ([12]) is also essentially different. In cross-section the upper tusks of *N. tasmanicum* are a full oval, while those of *N. victoriæ* are so compressed as to show an elongated oblong form. It is not possible to state definitely the exact length of either set of tusks in the case of *N. victoriæ*, as their alveolar ends are missing, but their outline, tending as it does to contraction, strongly suggests a much weaker and shorter type of tusk than that which obtains in the other species. The left cheek of *N. tasmanicum* has been denuded of its outer bony table along the line of the alveolus of the tusk, thus giving a perfect view of the tooth in its socket. Seen thus it is obvious that, like the tusk of a wombat, it is of almost even length throughout.

At the level of the two small incisors there is a slight reduction in girth as the tooth advances to form the exposed cutting edge. Measured along its chord this tusk is from 155 to 160 mm. in length, its girth at the base being 100 mm. The associated lower tusk is more robust, and measures 115 mm. in girth at the base. All four of the sub-median incisors are in splendid condition, and still firmly fixed in their sockets. On the right side the first of these lateral teeth is juxtaposed against the side of the tusk at an angle of 30 degrees to the line of the palate. The second incisor presses distally against its mate, but makes a small angle of only 10 degrees to the palate-line. This arrangement is the necessary outcome of the upbending of the nasal regions of the skull and the need for a working socket-like surface for the lower tusk. Assuming that in the normal state of rest the jaw would be slightly withdrawn so as to remove the tusks from the lateral incisors, I

([12]) Arrived at by placing them against the skull of *N. tasmanicum*, and orientating them to normal angle by means of the stained enamel surfaces.

have restored the right tusk to a length of 70 mm., measured from tip to alveolus. This length permits of a crown suited to the size of the socket, with no undue straining of the outlines suggested by those portions of the tooth still in the alveolus and also produced therefrom. The left-hand teeth are similar to, and agree with, those upon the right side of the skull. The right mandibular pre-molar is a narrow, elongated, much-worn tooth, with its crown ground to a chisel edge, the bevel being outwards. On the interio-posterior edge there is a slight trace of the original coronal prominence in the shape of a small loop of dentine, the survival of which has direct reference to the cusping of the upper tooth which opposed it. In point of rooting it is fixed to the jaw by two strong, slightly divergent fangs of almost equal size. The upper associated pre-molar is larger and more complex in every way; its rooting, also, is different: the posterior fang viewed from the inside seems much larger than the anterior, but upon the outer side of the skull the two vertical alveolar ridges are of about equal size, and herein agree with those of the first true molar. In its present worn condition it shows an anterior (central) tubercle, a large twisted posterio-transverse loop of dentine, and a posterio-internal tubercle worn down to a ring. The small loop which survived attrition in the mandibular tooth apparently occluded between the posterior tubercle and the large dentine loop of the upper tooth. It is easy to see how such an unquestionably *Nototherium* tooth as that figured by Glauert (*loc. cit.*) would in time degrade into the generic model of that found in the skull of *N. tasmanicum*. Roughly depicted, without special regard to scale or to the accuracy of the sub-oval outline of the tooth, the cusping of the upper pre-molar may be represented by the following diagram:—




The first lower true molar is also a much-worn tooth. Its cusping has disappeared, leaving only an approximately rectangular, shallow, concave outline in place of the original crown.

The upper associated molar is about equally worn, and exactly conforms to the altered condition of its mate, thus making grinding surfaces similar to those found in the teeth of elephants, although, of course, on a greatly reduced scale. The

second lower molar is fairly well preserved, the transverse ridges being still intact, although the enamel is worn through to the dentine—especially in the anterior regions. Its superior associate, however, reverses the conditions found in the upper molar number 1, and instead of being less worn than its mate, it is considerably more so. It is also practically devoid of all enamel, excepting the outer tables of the tooth. In this reduced condition the crown presents a nearly uniformly concave outline. Mandibular molar number 3 shows for the first time the true outline and cusping of a *Nototherium* molar tooth, namely, a massive tooth with two transverse enamel-capped ridges arranged slightly *en echelon*, the valley being also coated with enamel. In the present specimen this valley enamel is perfectly smooth and white. In some of the King Island teeth the enamel is punctate. This may be partly an age character, as the animal from King Island was apparently slightly younger, although fully adult and with worn teeth. Nevertheless it may be an individual variation as to intensity, and an age character as to extinction. The upper molar number 3 is worn to much the same extent as its associate of the mandible, the enamel ridges being ground down to two elongated loops of dentine.

Upper and lower molars number 4 are fairly perfect, their crowns as regards attrition being similar to their immediate predecessors; both are large and massive teeth, with a well-marked cingula of enamel. An interesting point in dental modification is observable here; it is one which perhaps throws light upon some of the confusion surrounding former descriptions of isolated teeth of *Nototheria*.

In the mandible of *N. tasmanicum* the two last molars (m. 4) have both lobes of almost equal size, the hindermost, if anything, being larger than their fellows. In the upper jaw both teeth agree in having the hindermost lobes considerably smaller than the anterior ones. In the mandible and upper jaws of *N. victoriæ* all four teeth have the posterior lobes smaller than the anterior ones and to about an equal extent. This may be suspected to be a sex character.

Professor Owen, in his "Odontography," stated ([13]) that in the mandible of *N. mitchelli* the fourth molar was in advance of the base of the coronoid process. In *N. tasmanicum* it is only the anterior two-thirds of the tooth, and in *N. victoriæ* the anterior half only. This point, as indeed many of the other points just presented, is noted without any reference to taxonomy, but with a view rather of putting on record the data collected from a study of these teeth. The differences noted (and still others) are sufficient to show a departure from the type equal to—if not greater than—that observable in the teeth of any existing wombats of admitted specific distinction. Upon the whole, there is a great similarity in the character and extent of the molar attrition on both sides of the skull, no strongly

([13]) "Odontography," by Richard Owen, 1845, Vol. 1, page 396.

marked bias being evident. In the case of molars numbers 3 and 4 the wear is very similar and to about the same extent. When the two double-tooth lines are considered in totality, however, it is obvious that during life the animal chiefly comminuted its food upon the cusps of the anterior regions of the tooth-line. In the specimen of *N. victoriæ* available individual bias is manifested in an almost even distribution of the work of grinding the food over the whole tooth-line, and thus most of the cusps show a similar amount of wear. The two teeth described by L. Glauert from the Mammoth Cave, Western Australia (*loc. cit.*), supply a molar and a pre-molar for direct comparison with our specimens, and I therefore reproduce his excellent description in full :—

"MOLAR.

"The bi-lobed molar has a rhomboidal outline, narrower posteriorly, with the angles obtusely rounded; the anterior surface and the sides measure from 35 to 36 mm. in linear extent; the length of the posterior face is 32 mm. The two lobes of the teeth are parallel and *en echelon*, the hind lobe projects farther inwards, and is shorter and narrower; each lobe has a slight swelling at the extremity, is convex on the anterior face and concave backwards. The crest of each lobe is obliquely truncated, the exposed dentine sloping anteriorly. As the fore lobe is more worn than the hind one, it has developed a larger tract of bared dentine.

"Distinct anterior and posterior basal ridges are present; each terminates in a tuberosity at its outer end, and does not ascend the outer side of the lobe. The posterior ridge and tuberosity are less developed than the anterior ones. The inner continuation of the anterior basal ridge rises upon the interior face of the hind lobe, gradually diminishing as it approaches the summit. On the posterior face of this lobe it descends to form a ridge closing the inner end of the mid-valley; it then rises on the fore side of the hind lobe, subsiding towards the summit. A continuation of the posterior basal ridge rises upon the anterior face of the hind lobe. On the outer aspect of the tooth a distinct isolated ridge closes the outer end of the mid-valley. At a point in the mid-valley of the tooth about one-fourth from the outer border a slight swelling or rudimentary link connects the two lobes; from this point the surface of the valley slopes gradually to the inner and outer confining ridges. The unworn enamel seen on the floor of the mid-valley and near the anterior and posterior ridges is punctate."

From the above description of what I take to be left upper molar number 3, the same tooth in *Nototherium tasmanicum* departs in the following details. Instead of the two lobes being rounded inwards towards the palate and swelling

at the gum-line into a cingulum, the whole inner surface of the tooth combines to form a nearly flat surface, which arises gradually out of the fangs. The posterior basal ridge, in place of being strongly developed and practically half-encircling the lobe, is restricted to the actual point of contact with molar 4, and has obviously never exceeded this extent, since the external tubercle which marks its termination is still present. Also, in our specimen the mid-valley has been bisected by a bulging ridge of enamel thrown out chiefly by the anterior lobe: this cuts the valley up into two moieties of practically equal size. The anterior basal ridge was apparently traversed by a stout basal spur similar to, but larger than, that found in the mid-valley. Its surface contact with molar number 2 is extended for 20 mm. (as against 15 mm. in the case of the same tooth in *N. victoriæ*). The basal ridge terminates abruptly in a tubercle, which opposes a similar one in the posterior lobe of the anterior tooth, the ridge not extending on to either the outer or palatal aspect of the fang.

The two lobes of the tooth are very unequal in size and in point of measurement: in this connection the three teeth give the following results:—

*Comparative Molars* (*No.* 3).

| Name of Tooth. | Front Lobe (width). | Back Lobe (width). | Total Size (length and width). |
|---|---|---|---|
| | mm. | mm. | mm. mm. |
| Molar No. 3—left upper (Glauert) ... ... | 35 to 36 | 32 | 40 × 35 |
| Ditto of *N. tasmanicum* ... ... ... ... | 35 | 29·5 | 39 × 35 |
| Ditto of *N. victoriæ* ... ... ... ... ... | 35 | 31 | 40 × 35 |

Thus it will be seen that the posterior lobe of the tooth in *N. tasmanicum* is 2·5 mm. narrower than that of the West Australian molar, although the total size is nearly the same. This amount is very considerable in a tooth, and quite changes its aspect when viewed from above. When we come to the molar of *N. victoriæ*, Mr. Glauert's description is so absolutely accurate for it in all its details of ridges, tubercles, and enamel surfaces, that it might very well have served for the model of his text, the one and only departure being the reduction in width by 1 mm. of the hind lobe of the tooth.

As Mr. Glauert considers the pre-molar tooth from the Mammoth Cave as reproducing the essential conditions of De Vis' defence of Macleay's *Zygomaturus trilobus*, he records *Zygomaturus* as a synonym. This tends to bring *Zygomaturus*, the Western Australian *Nototherium*, and *Nototherium victoriæ* closer together, and they may yet be all remains of female animals, as the weak tusks of *N. victoriæ* suggest that sex.

Immediately hereunder in tabular form is an analysis of the respective sizes of the teeth—from the tusks to the posterior molars.

| Name. | Nature of Measurement Made. | Nototherium tasmanicum. | Nototherium victoriæ. |
|---|---|---|---|
| | *Tusks.* | mm. | mm. |
| Right mandibular tusk | Alveolus to tip (restored) | 70 | 50 (approx.) |
| Right mandibular tusk | Girth at alveolus | 115 | 91 ,, |
| Left mandibular tusk | Alveolus to tip (no data) | | 48 ,, |
| Left mandibular tusk | Girth at alveolus | | 92 ,, |
| Right upper tusk | Alveolus to tip | 65 | 48 ,, |
| Right upper tusk | Girth | 100 | 75 ,, |
| Left upper tusk | Alveolus to tip | 66 | 48 ,, |
| Left upper tusk | Girth | 101 | 80 ,, |
| | *Upper Incisors.* | | |
| Right-small-incisors | Extent of surface for action against lower tusks | 25 × 12 | |
| Left-small-incisors | ditto | 24 × 11 | |
| | *Pre-Molars.* | | |
| Right mandibular pre-molar | Length and width of the crown in present state | 17 × 8 | |
| Right upper pre-molar | ditto | 24 × 18 | |
| Left pre-molars missing | No data | | |
| | *Molars.* | | |
| Right molar No. 1 of the mandible | Length and width of crown in present state | 27 × 19 | |
| Right upper molar No. 1 | ditto | 28 × 18 | 26 × 27 |
| Left mandibular molar No. 1 | ditto | 26 × 18 | |
| Left upper molar No. 1 | ditto | 28 × 27 | 28 × 26 |
| Right mandibular molar No. 2 | ditto | 36 × 27 | |
| Right upper molar No. 2 | ditto | 34 × 23 | 34 × 31 |
| Left mandibular molar No. 2 | ditto | 33 × 25 | 30 × 23 |
| Left upper molar No. 2 | ditto | 35 × 30 | 32 × 33 |
| Right mandibular molar No. 3 | ditto | 40 × 32 | 39 × 30 |
| Right upper molar No. 3 | ditto | 39 × 35 | 40 × 34 |
| Left mandibular molar No. 3 | ditto | 42 × 32 | 42 × 29 |
| Left upper molar No. 3 | ditto | 39 × 35 | 40 × 35 |
| Right mandibular molar No. 4 | ditto | 42 × 33 | 40 × 30 |
| Right upper molar No. 4 | ditto | 41 × 34 | (missing) |
| Left mandibular molar No. 4 | ditto | 39 × 32 | 38 × 30 |
| Left upper molar No. 4 | ditto | 41 × 36 | |

## Recapitulation.

Irrespective of such minor and incidental characters as may be claimed to illustrate individual variation, the skull, tooth-line, and mandible of *N. tasmanicum* depart considerably from Professor Owen's type species *N. mitchelli.*

Any one character, regarded as an isolated factor, might well be objected to as falling below the demands of specific distinction, but the following cumulative facts are strongly suggestive of segregation from the mainland type. The skull presents a 5·21 per cent. greater proportional facial elongation than the type, with an actual 11·5 per cent. nasal reduction in width. This proportional nasal increase over the type is 0·61 per cent. more than obtains in the specifically distinct wombats, *P. latifrons* and *P. mitchelli.* There is also a vastly greater upbending of the nasal regions, as shown in Plate 22, together with a much elongated symphysis and a reduced tooth-line. The variations in the teeth are considerable, but less stress is laid upon them, as they obviously vary enormously in individuals and somewhat with sex. See also notes under heading of " Concluding Remarks."

# The Humerus.

As much of the weight of my classification was originally thrown upon the humerus, this bone was practically elevated to the type of the species, and consequently it is necessary to make an unusually exhaustive examination of it in order to support the claims resting upon its osteological peculiarities. When my first notes were published, I assumed that an osteological description of a humerus which departed materially from the type would be accepted by all workers in the field of natural history as good and sufficient grounds for establishing a new species. Finding, however, this assumption to be unwarranted, I next made a wider survey of humeral characters, and detailed those of elephants, living and extinct. This selection of the arm-bones of elephants was made because there is every likelihood of a similar method of articulation in *Elephas* and *Nototherium*. Mr. Lydekker, in his catalogue ("Catalogue of Fossils in the British Museum," Vol. 5, page 170), referring to the allied *Diprotodon*, says: "The proximal bones of the limbs were apparently placed nearly vertically, and appear to have been adapted solely for walking." I shall revert to this question of pose and habitual attitude in my general conclusions, only remarking here that, upon the assumption of an actual or nearly vertical articulation of the humerus in the *Nototheria*, the humeri of elephants furnish us with the best comparative series of specific characters, as their limb-bones are similarly arranged. The researches of such illustrious workers as Professor Owen, Professor Leith Adams, and (recently) Dr. C. W. Andrews, have put us in possession of a chain of evidence which bears directly on the subject. My published notes in this connection were as follow:

"*Humeri of Elephants, Living and Extinct.*

(See Plate No. 5.)

"1. *Palæomastodon*.—Humerus with curved shaft, high swelling deltoid regions, supinator ridge low upon the shaft.

"2. *Elephas primigenius*.—Shaft more symmetrical, deltoid still high, but less abrupt, supinator ridge ascending higher up the shaft.([14])

"3. *E. meridionalis*.—Deltoid coming down the shaft, supinator better defined, and approaching it.

"4. *Elephas antiquus*.—(Not then noted, but introduced into the present figure.)

([14]) At page 252 of "Brit. Foss. Mam." Prof. Owen says: "It manifests the specific distinction of the humerus of the mammoth in the relatively shorter proportion of the great supinator ridge"—thus giving to such characters the exact value I claimed for them in the establishment of my type humerus.

"5 and 6. The humeri of the two modern elephants vary chiefly in the deltoid regions, asiaticus being more pronounced, and the shaft wider proximally. The humerus of *Nototherium tasmanicum* departs from that of *N. mitchelli* in exactly the same way as *Elephas primigenius* and *E. meridionalis* depart from one another, and incidentally from *Palæomastodon*."

To illustrate these points I have made outlined sketches of the several humeri here named, and also an outline of the humeri of *Nototherium mitchelli* and *N. tasmanicum* (see Plates 5 and 6). A glance at these figures is sufficient to show that the several species differ largely in the relative positions of their deltoid and supinator processes, and a second glance at the humeri of the two *Nototheria* (Plate 6) will supply similar data. The pectoral ridges of these two humeri should also be compared.

| Table of Comparative Humeri. | N. mitchelli. | N. tasmanicum. |
|---|---|---|
| | mm. | mm. |
| Total length of humerus | 400 | 467 |
| Proximal width | 122 | 125 |
| Theno-anconal thickness of head | — | 93 |
| Distal width | 224 | 175 |
| Ditto, condylar articular surface | — | 124 |
| Least width of shaft | 80 to 82 | 62 |
| Thickness of shaft, from pectoral ridge to anconal surface | — | 60 |
| Greatest width at unciform process of the supinator ridge | 140 | 90 |
| Thickness of radial condyle | — | 58 |
| Thickness of ulnar condyle | — | 60 |
| Length from unciform process to deltoid process | 60 | 35 |
| Thickness of bone at unciform process of the supinator | — | 5 |
| Length of pectoral ridge from the ectotuberosity to the pectoral process | 234 | 238 |

An examination of these measurements will show that the humerus of the Tasmanian animal is not only *much longer* than that of the mainland, but is distally much narrower and constricted at the region of the unciform process. Another most striking character in the Tasmanian bone is the manner in which the "unciform" and "deltoid" processes approach one another, notwithstanding extra length of the shaft as a whole. The Tasmanian humerus also differs in the region of the entepicondylar foramen: for if it is placed upon a flat surface with the thenal side upwards, the actual bony bridge overlaps the edge of the shaft, which latter is "undercut" or bevelled away at a steep angle which differs materially from Professor Owen's figure. Lastly, in the humerus of *N. tasmanicum* the

bridge itself is narrow and of almost equal width throughout, while that of the type species is proximally more massive. In spite of its great length, in which it exceeds the type by 67 mm., the humerus of *N. tasmanicum* is so reduced in width as to fall below the type to the extent of 49 mm., a reduction which affects the regions usually allotted to the attachment of such muscles as the pronator radii, flexor carpi radialis, and flexor carpi ulnaris, together with the extensor carpi radialis and ulnaris.

The anconal face of the shaft is an almost uniformly flat surface, from which, proximally, the head arises rather abruptly, while distally the condylar articular tracts are scarcely elevated above the general contour of the shaft. The olecranon fossa is shallow and imperforate, measuring 60 mm. by 30 mm. Nothing could be more characteristic than this smooth flat surface—its smoothness suggests the heavy movement of the elephant, and not the bounding activity of the kangaroo. The only roughened muscular attachment scars are, first, one upon the upper radial edge of the bone, and a second smaller scar upon the ulnar edge, this latter being for the attachment of the triceps and teres major muscles.

The thenal view of the humerus is, however, much more complex, and, regarding the anconal surface as the base of a triangle, the apex is here manifested in the long pectoral ridge. This ridge arises proximally as the bounding wall of the bicipital groove and the median portion of the great humeral tuberosity. The distal end of the pectoral ridge extends to the middle of the roughened deltoid tract, which is exactly the reverse to that which obtains in the humerus of *N. mitchelli*, in which species the deltoid is kept well up the shaft. The supinator has a hamular or unciform process, and the whole edge of the shaft in this region is reduced to extreme thinness—the thinning away being entirely from the thenal surface of the bone. Two nutrient foramina occur on the ulnar side of the thenal surface—one about 35 mm. from the end of the pectoral ridge, and the second 70 mm. distally removed from it. From the plates given in illustration of this humerus nearly all the points noted can be directly checked, and any comparison of such with Professor Owen's published figures of his type species, *Nototherium mitchelli*, will make distinctly evident how different a humerus we are here dealing with. These two distinct types of humeri, as thus contrasted, and represented by *Nototherium mitchelli* with its moderate length, great width, and large double deltoid placed high upon the shaft, and that of *Nototherium tasmanicum* with its elongated narrow shaft and lowly placed deltoid—have to a large extent examples among modern wombats, except that the characters are reversed in the following way :—

No. 1. Wide humerus, straight in shaft, deltoid fairly low, but higher than the end of the pectoral, bridge of foramen narrow. Examples : *Phascolomys mitchelli, P. tasmaniensis.*

# The Scapulae.

In our specimen the right scapula is fairly complete along the pre-scapular edge, but is mutilated on the post-scapular edge. The left scapula is mutilated in exactly the opposite way, but, with one small exception, it is possible to work out the characteristic osteology of the specimens. The general outline of these bones is similar to that possessed by the scapulæ of *Diprotodon*, namely, narrow and elongated, with heavy and roughened supra-scapular borders of some 80 mm. in vertical extent. As the two specimens are shown on Plate 9, it is unnecessary to extend this part of the subject. The strongly marked pre-scapular prominence (*vide* A., Fig. 1, Plate 9) is, if anything, higher up than in the *Diprotodon*, but this is obviously an extremely minor point. Also, compared with the scapula of *Diprotodon*, the spine and acromion are similar, but the post-scapular area is apparently relatively wider. Beginning at the roughened outline of the completely ankylosed supra-scapular epiphysis, the pre-scapular fossa is seen to be a dish-like depression with a diameter of 95 mm. From thence downward around the whole region of the pre-scapular prominence the surface is elevated, but soon giving place distad to a shallow groove which contracts to a minimum width of 25 mm. The post-scapular surface is proximately slightly concave, and might even be said to form a shallow basin-like depression of 60 mm. diameter in all directions. Thence distad for 70 mm. the bone bulges up in a transversely convex manner, being fairly uniform in contour for the distance named. Thence mesiad and distad it becomes concave, and continues so to the constriction of the glenoid—the greatest concavity following the line of the spine.

As the post-scapular edge is curious and unusual, it may be of interest to trace its course distad from the bulging area noted above. Beginning with a slight concavity, the whole surface of the bone slowly rises from the rim inward, until at a total distance of 270 mm. from the apex of the spine (and therefore at its junction with the supra-scapular epiphysis) it throws up a big transverse ridge which becomes the bounding wall of a symmetrical groove-like fossa 20 mm. deep and 30 mm. wide. The lower (distad) wall of this groove apparently merged into a large post-scapular tuberosity, similar to that found at the distal end of the scapula of *Diprotodon*; in the latter animal, however, this fossa is missing, but may possibly reappear in part in *Phascolonus*. Unfortunately the tuberosity is missing from both our scapulæ, and therefore the actual outline is unknown.

The right scapula is perforated by two large well-marked nutrient foramina, the first of which is in the flat post-scapular surface of the bone, 110 mm. from the

glenoid cavity. The second enters the spine 100 mm. from the same point. The left scapula has no foramina; perhaps this is due to a greater use of the right hand.

*Measurements.*

| | |
|---|---|
| Total length of scapula from glenoid to supra-scapular border ... ... ... ... ... ... ... ... ... ... ... | 430 mm. |
| Supra-scapular border to apex of spine ... ... ... | 80 mm. |
| Size of glenoid cavity ... ... ... ... ... ... ... ... ... ... | 100 mm. by 70 mm. |
| Greatest thickness of scapula measured distad from acromion to inner wall of glenoid ... ... ... | 140 mm. |
| Width of spine, not including coracoid process, varies from ... ... ... ... ... ..... ... ... ... ... ... | 50 mm. to 20 mm. |

# The Radius.

The right radius and ulna of *Nototherium tasmanicum* are known proximally, while the lower bones of the left arm and the distal ends of the right are not available for study. A glance at the bones themselves, as indeed also at their photographic figure (see Plate 10), is sufficient to show that their normal articulation and position were those of pronation, with the superadded power of very considerable rotation. The fragment of the radius measures 245 mm. in length, the distal end being splintered by a long fracture with a face surface of 95 mm.; in the plate this is turned to the wall. The nature of the fracture leads me to believe that the rest of the shaft was in the matrix, but that, like the extensive mandibular fracture, it was caused during the excavation of the specimen. The head is nearly round, and measures 50 mm. by 48 mm., the elongation being conformable to the resting position of pronation. The neck of the bone is formed by a gradual slope of the shaft upwards, and not by any strongly marked constriction. The bicipital tubercle is a large oval scar 30 mm. long and 17 mm. wide; its lower end is 80 mm. distad from the head. As in the human subject, this scar can be divided into two distinct parts, one for the attachment of the biceps tendon and the rest for a synovial bursa.

The "oblique line" is indicated by a roughened tract which extends down what appears to have been the surface for the pronator radii teres. Just here, unfortunately, the long fracture of the bone starts, so that the actual cicatrice may possibly have been even lower down. This fracture is 165 mm. from the head of the bone.

There is also a considerable amount of roughening along the normal line of pronation, possibly related to the inter-osseous membrane.

The girth of the bone may be expressed as follows :—

| | mm. |
|---|---|
| Girth of head of radius ... ... ... ... ... ... ... ... ... ... | 160 |
| Girth of shaft at bicipital tubercle ... ... ... ... ... ... ... | 107 |

# The Ulna.

The ulna is a heavy, more or less prismatic, bone—our specimen being distally imperfect and slightly rubbed proximally in the regions of the olecranon process. All the articular surfaces are absolutely perfect, and the shaft is present for a total length of 343 mm. (see Plate 10). In greatest width, taken from the olecranon to the coronoid process, the bone measures 125 mm.

Immediately outside the lesser sigmoid cavity the base of the coronoid is penetrated by an oval scar-like fossa, 25 mm. long by 12 mm. wide and 8 mm. deep. This fossa, which can be seen in the photograph (with an arrow pointing up to it), is, I take it, for the lodgment of the orbicular ligament. Beginning at 65 mm. from the top of the lesser sigmoidal cavity, a long roughened tract extends down the bone for 190 mm., rising 7 mm. high in mid-course, and slowly subsiding upon the shaft. This tract largely outlines the normal position of the radius, and is probably associated in part with the attachment of the inter-osseous membrane. The small olecranon has direct reference to the shallow, humeral, olecranon fossa, and these several parts articulate best when the humerus is placed nearly vertical.

*Sizes of the Articular Surfaces.*

| | |
|---|---|
| Size of humero-ulnar articular cup ... ... ... ... ... | 65 mm. by 45 mm. |
| Size of olecranon portion of ditto ... ... ..... ... ... | 40 mm. wide and 30 mm. deep |
| Distance from centre of cup to top of olecranon ... | 30 mm. |
| Humero-radial tract (not including head of radius) | 50 mm. and 30 mm. deep |

# The Femur.

To avoid any chance of misunderstanding regarding my former and present views respecting the nature of Professor Owen's type femur of *Nototherium mitchelli*, I propose to reproduce my published notes, and then to add the results of my later investigations :

"*Femur.*

"Professor Owen's type skeleton of *Nototherium mitchelli* did not include a femur among its fossil remains; but five years after his description appeared a distal end of one came to hand, and its characters were duly detailed in the Journal of the Geological Society.([16]) This bone included the distal condyles, and as much of the shaft as went to make up a total length of 216 mm., and in dealing with the complete femur I shall call this point of the shaft 'Owen's line.'

"The femur of *Nototherium tasmanicum* has a fairly smooth shaft, almost completely oval in section, and quite unlike that of *N. mitchelli* (see comparative outlines), (Plate 12). The head surmounts a short neck set at an angle to the main shaft of 40 degrees, and is so absolutely round as to give equal diameters in all directions. The trochanter major gives expansive surface for muscular attachment, and is pierced by an oval trochanterian fossa, 51 mm. X 32 mm. in size, penetrating the bone (at an angle of 20 degrees to the centre of the shaft) to a depth of 38 mm. The second and third trochanters are indicated by cicatrices, the latter being an oval scar 50 mm. X 40 mm. Distally—and therefore comparatively—the ecto and ento-condyles are larger than those of *N. mitchelli*, while the intercondylar fossa is less extensive. The condyles also differ in shape, while the manner in which the shaft in the neighbourhood of the ecto-condyle rises above them is markedly different. Indeed, compared with this type, the essentially different sectional shapes of the two femora supply various specific contrasts, as might be expected.

([16]) Journal Geo. Society, August, 1882, page 394.

"*Comparative Femora.*

| | N. mitchelli. | N. tasmanicum. | Femur from Buchan Cave, Victoria. (161) |
|---|---|---|---|
| | mm. | mm. | mm. |
| Breadth across condyles ... ... ... ... ... | 145 | 153 | 116 |
| Breadth of shaft section at Owen's line... | 77 | 85 | 61 |
| Antero posterior section at Owen's line... | 56 | 52 | |
| Circumference of ditto at Owen's line... | 212 | 220 | |
| Circumference above condyles ... ... ... . . | 309 | 381 | |
| Circumference including condyles ... ... | Not stated | 451 | |
| Breadth of rotular joint ... ... ... ... ... | 56 | 86 | |
| Breadth of intercondylar fossa ... ... ... | 35 | 19 | 26 |
| Greatest length of femur ... ... ... ... . | Not given owing to mutilation | 475 | 460 |
| Greatest width between two vertical walls. | ,, ,, | 204 | 141 |
| Girth of shaft at lower edge of the trochanterian fossa ... ... ... ... ... ... ... | ,, ,, | 420 | |
| Girth below head ... ... ... ... ... ... ... | ,, ,, | 251 | |
| Diameter of head, in all directions ... ... | ,, ,, | 83 | 77 |
| Length of neck ... ... ... ... ... ... ... ... | ,, ,, | 63 | |
| Thickness of shaft, at trochanter major ... | ,, ,, | 95 | |
| Distance from top of trochanterian fossa to epi-trochanterian surface ... ... ... | ,, ,, | 25<br>25 | |
| Distance from head to trochanter minor | ,, ,, | 178 | |
| Distance from head to nutrient foramen | ,, ,, | 152 | |

(161) The measurements of this femur were made from a photograph that included a scale in the field—approximate only.

"Starting from the inner edge of the ento-condyle, a spiral muscular groove ascends the shaft, finally losing itself upon the inner edge 150 mm. from its source.

"The 'ligamentum teres' was apparently missing, as there is no depression in the head for its insertion, and in this the animal agrees with the extinct Ground Sloth and *Dinoceras*, as also the living Elephant, Sea Otter, Seal, Orang Utan, and the Monotremata."

Up to the time I published the first two of these comparative columns, I had no suspicion that the femur regarded as being that of *Nototherium mitchelli* might be relegated to any other animal. The addition, however, to the Museum collection of a shaft of a femur of *Phascolonus* recovered from the Mowbray Swamp at Smithton, and generously presented to us by the Minister of Lands (the Hon. E. Mulcahy), led me to compare this shaft most carefully with Professor Owen's

figure of the femoral section of his type bone of *Nototherium mitchelli*—the result being that the section strongly suggested *Phascolonus*. Since the publication of Dr. Stirling's monograph on *Phascolonus* I have gone into the question again and collected various data both for and against.

Quite recently I called Dr. Stirling's attention to Professor Owen's published figure, and he immediately remarked that it looked like *Phascolonus*. I cite this, not as a definite opinion, but to show that one coming directly from a long series of investigations of the osteolgy of *Phascolonus* gained the immediate impression that the femur was that of a *Phascolonus*, and not of a *Nototherium* at all. To my mind one of two things is certain—either the femur is a very robust *Phascolonian* one, or the variation in the two species of *Nototheria* is enormous. In this connection I may add that Mr. R. Lydekker, in his " Catalogue of Fossil Mammalia in the British Museum " (Vol. 5, p. 168), in dealing with the type femur (Specimen 48,418), says : " The specimen agrees in structure with the femur of *Phascolomys* (wombat) and in relative size with the humerus." Now anyone who will compare the femur of our *Nototherium* with that of the wombat would never say that they agree, unless in the case of that from King Island. In fairness I must recapitulate the circumstances in which Professor Owen determined the distal end of a right femur, and relegated it to *Nototherium mitchelli*.

In 1877 Dr. George Bennett presented to the British Museum the distal end of a right femur (Catalogue No. 48,418), and in June, 1882, Professor Owen described the bone, his description being published in the Quarterly Journal of the Geological Society, Vol. 38, No. 151. This it will be noted was later in time than the publication of the historic monograph, " The Extinct Mammals of Australia." To deal successfully with this isolated fragment, Professor Owen adopted an extensive system of comparison and elimination, passing in review all the likely items in the list of extinct creatures, and slowly rejecting such as did not correspond with the facts. When he came to *Phascolonus* he wrote : " The size of the fossil is greater than that of the femur of the largest known extinct wombat in the degree in which the mandible and teeth of *Nototherium mitchelli* surpass those of *Phascolonus gigas*. Upon the foregoing comparisons I therefore framed the conclusion that the distal portion of the femur here described belongs to a species of *Nototherium* as large, if not the same, as *Nototherium mitchelli*."

If my comparative table of measurements of the two femora be consulted, it will be seen that, upon the question of size, this was good and sound logic, the more so as little was known of the femora of *Phascolonus*. For up to the date when the professor wrote this, the only femur of *Phascolonus* which had reached him was the distal end of a small femur from the Condamine River, Queensland.

No data were available for the restoration of this assumed *Nototherian* femur beyond the broad fact of Owen's great knowledge of osteology and the assistance gained by a study of ratios culled during an examination of the *Phascolonian* tibia and femur, of which bones it has been said :—

> "No. 40,381 (Cat. Foss. Mam. Brit. Mus., Vol. 5).—The distal portion of a left femur from the Pleistocene of the Condamine River, Queensland. This bone agrees in size with the next specimen.
>
> No. 38,782.—Left tibia from Darling Downs; the length is 180 mm."

Dr. Stirling has recorded a tibia of *Phascolonus* with a total length of 206 mm. It is therefore evident that the British Museum specimen available to Professor Owen was not one of maximum length. So, working chiefly on ratios, and assuming that the imperfect (so-called) *Nototherian* femur was, in the mutilated condition, half its full size, Owen was faced with the following problem :—

(1) Femur (called *Nototherium*) half-size, 216 mm. The total size would be 432 mm.

(2) Tibia of *Phascolonus*, 180 mm., and apparently an average specimen, with osteological characters in common with those of wombats.

(3) Condamine River : imperfect femur agrees in general characters with the wombat, and is evidently uniform in size with the tibia; therefore the larger femur must belong to a *Nototherium* or to some other genus than *Phascolonus*.

The Tasmanian femur shaft of *Phascolonus*, alluded to *supra*, is devoid of both ends; even in that mutilated condition it is 345 mm. long, and might easily have gone over 400 mm. long when perfect, so that Owen's so-called *Nototherium* femur is not necessarily too long for a femur of *Phascolonus*—the more so in that it cannot be accurately stated that one-half, and only one-half, of the shaft is present. In width, however, our *Phascolonus* shaft falls considerably below that of Owen's type femur.

To sum all this up in a few words : either the type bone called femur of *Nototherium mitchelli* is a very robust femur of a *Phascolonus*, or the two femora of *Nototherium mitchelli* and *Nototherium tasmanicum* depart from one another enormously. If the former is correct, the femur of *Nototherium mitchelli* is unknown. If the latter is correct, the species *N. mitchelli* makes a much nearer approach to the wombat group than does *N. tasmanicum*. Lastly, as two immature femora of *Nototherium tasmanicum* are available in different stages of growth, and the two bones of our type are present and all agree in departing from the wom-

bat type of femur, it is evident that age can have nothing to do with the problem. These facts are simply recorded in passing as arising from a study of the actual specimens; the settlement of the question remains for the future.

Owen strongly pointed out in his paper that the femur which he assigned to *Nototherium mitchelli* departed from the *Diprotodon* and approached the wombats. But an examination of the shaft sections given in Plate 12 of this monograph will show that our femur approaches *Diprotodon* more nearly than it does the obviously wombat type of shaft illustrated by the Hunterian professor.

Through the courtesy of Dr. Stirling I am able to reproduce a photograph of a femur which was found in the Buchan Cave in Gippsland, Victoria (see Plate 21). This bone is essentially phascolomyform, and in many respects approaches Owen's type of *N. mitchelli*; indeed, notwithstanding some variation in point of size, I am convinced that it is a similar femur to that distal fragment which Owen relegated to the *Nototherium*. It departs from the femur of *N. tasmanicum* in many respects, and is at least generically distinct from it. A glance at the two photographs will make much of this evident, but it may be said that the bones differ in length and section of shaft, in the pose of the head, the nature of the trochanter and the trochanterian fossa, and, in short, that while the cave bone is that of a gigantic wombat (possibly new to science), the femur of *N. tasmanicum* is peculiar to itself, and (if Owen's femur is incorrectly relegated) is the only definitely determined *Nototherian* femur at present accessible for inspection.

## The Tibia.

The right tibia and fibula are here selected for study, as the left fibula is imperfect distally. In outline the tibia is longer, more slender in the shaft, and less disproportionate in the ratios of its proximal and distal width than those of *Phascolonus*, and apparently approaches more nearly to the tibia of *Diprotodon* than it does to that of the giant wombat. In the latter the proximal width is double that of the distal, and in *Nototherium* it is as five to four. If the two figures (2 and 3) of Plate 13 are examined, the exact outline of a *Nototherian* tibia can be estimated.

In Fig. 2 the left tibia is seen in a partly external aspect, but slightly rotated to bring the fibular articular facet to the front. Fig. 3 is a full-faced view of the right tibia, showing proximally the angle made by the external condylar articular rim with the general line of the shaft, also as an individual variation a bony tubercle in the regions of the fibular articular surface.

The shaft of the bone is twisted upon itself in such a way as to bring the distal end to an angle of 45 degrees from the line of the proximal fibular facet. Fig. 3, Plate 13, is arranged to illustrate this, the proximal end being a full face line and the distal end twisted to the angle stated, thus turning inwards the face of the shaft to conform with the needs of the fibula which crosses it.

The external femoral articular cup forms three parts of a circle 60 mm. in diameter, and terminates towards the internal condylar articular surface in a rudimentary spine. The internal condylar surface is roughly a truncated triangle measuring 60 by 40 mm. This surface, as shown in Fig. 3, gives a good idea of its shallow ogee-shaped line, while in Fig. 2 its triangular aspect is a little more apparent. The non-articular portion is an oblong area 90 mm. long by 60 mm. wide, bounded on its anterior and inner edges by a well-marked rim, relating, I presume, to a semilunar cartilage and an extensive coronary ligament. The rim terminates at the fibular end in an oval scar 30 mm. by 15 mm. in extent. As a whole, the shaft is fairly smooth. One muscular tract, 110 mm. in extent, immediately underlies the position of the fibula, and a second oval scar 70 mm. by 20 mm. long arises out of a roughened line which extends proximad to within 45 mm. of the external condylar articular rim. Practically the whole distal end of the bone is occupied by the extensive astragalar articular surface, which is broken upon the internal edge by a fairly deep gorge for the reception of the astragalar articular eminence or process, and posteriorly upon the same side by a fossa 10 mm. long, 5 mm. wide, and 10 mm. deep. The actual measurements of the distal articular surface are as follow:—Greatest length, 80 mm.; greatest width, 60 mm. The non-articular surfaces add somewhat to the distal extent in the degree noted in the following table:—

*Size of Tibia.*

| | mm. |
|---|---|
| Total length between two vertical walls ... ... ... ... ... | 284 |
| Greatest proximal width ... ... ... ... ... ... ... ... ... ... ... | 125 |
| Greatest distal width ... ... ... ... ... ... ... ... ... ... ... ... | 88 |
| Least distal width ... ... ... ... ... ... .. ... ... ... ... ... | 63 |

# The Fibula.

The outline and general appearance of the fibula can be determined by a study of Fig. 1 in Plate 13, in which it is presented with its inner or tibial side to the front. Seen thus, its chief characteristics are the articular portion and the extensive fossa for muscular attachment, bounded by the heavy inter-osseous ridge. When placed in position against the tibia, and viewed end on, it presents an almost pear-shaped outline with respect to its particular part and a roughened triangular non-articular surface. The former is 50 mm. long by 30 mm. wide, and the latter is 45 mm. long by 20 mm. wide.

Distally the outline of the bone is subelliptical, the articular angle as a whole cutting the shaft at about 35 degrees. The distal end, articular and non-articular, measures 65 mm. by 42 mm. The external malleolus is fairly well developed, and is deeply scored for muscular attachment.

| *Measurements.* | mm. |
|---|---|
| Total length between verticals ... ... ... ... ... ... ... ... | 248 |
| Greatest proximal width ... ... ... ... ... ... ... ... ... | 73 |
| Least proximal width ... ... ... ... ... ... ... ... ... ... | 64 |
| Greatest distal width ... ... ... ... ... ... ... ... ... ... | 52 |
| Least distal width ... ... ... ... ... ... ... ... ... ... ... | 43 |

# The Astragalus.

The left astragalus of *Nototherium tasmanicum* is shown in Fig. 3 of Plate 14, while Fig. 1 of the same plate shows that of *N. victoriæ*, the latter bone being from the right leg. Direct comparison with Dr. Stirling's published figures of the astragali of *Diprotodon* ([17]) and *Phascolonus* ([18]) shows that, as regards the proportion of length to width, the *Nototheria* approached the extinct gigantic wombats nearer than they did the *Diprotodon*, but as the taxonomic relationships of the *Nototheria* are as a whole closer to the *Diprotodon*, my comparisons of the astragali will be with those of the latter. Arranging the astragalus with its proximal side upwards, and therefore in normal position as regards its articula-

([17]) Mem. Roy. Soc. South Australia, Vol. 1, Part 1, Plate XI.
([18]) Mem. Roy. Soc. South Australia. Vol. 1. Part 4, Plate LVIII.

tion with the leg, and holding the head in the hand, the outline presented is that of a fan, the upper edge of which is cut up into five elevations and four valleys. To obtain this view of the bone, the photograph must be turned upside down, and even then it will only be partly manifest, for the tilt of the bone lowers the elevations to some extent. In *Diprotodon* this upper edge is fairly well rounded, and tne outline of the bone as a whole is longer in proportion to width than obtains in *Nototherium*. In a general way a description of the astragalus of a *Diprotodon* would apply to that of a *Nototherium*, but the following details may be given :—

Above the head, and undermining the tibio-astragalar articular eminence, is a fossa which gives inlet to an orbicular articular ligament. The fossa itself is 20 mm. in diameter and the foramen 6 mm. in diameter and 32 mm. in total depth from its internal end to the rim of the head. In the photograph an arrow points to the fossa and the outlet of the foramen. A similar arrow points to this foramen in the astragalus of *N. victoriæ* (Fig. 1), but the whole arrangement is here different, as the foramen is carried vertically downwards through the floor of the fossa, which is in itself extremely shallow, and does not undermine the tibio-astragalar prominence at all, but strikes vertically into the bone well away from its base. Of specific (if not eventually shown to be sexual) variation in the astragali of *Nototheria* may be noted the smaller and thinner bone of *N. victoriæ*, the evenly excavated tibial articular surface, the well-defined tibio-astragalar eminence, forming a true bounding wall of a well-marked valley; this in part can be seen in the photograph. The above is in contrast to that found in *N. tasmanicum*, where the whole of the central portion of the tibial articular surface is anterio-posteriorly convex instead of concave, so much so that if the other bone had not been available for comparison, it would never have been called a valley at all.

Appended is a table of comparative measurements of the astragali of *Nototherium tasmanicum* and *N. victoriæ* :—

*Comparative Sizes.*

| Nature of Measurement Made. | N. tasmanicum | N. victoriæ. |
|---|---|---|
| | mm. | mm. |
| Greatest length ... ... ... ... ... ... ... ... ... ... ... ... ... | 100 | 84 |
| Greatest width ... ... ... ... ... ... ... ... ... ... ... ... ... | 91 | 79 |
| Greatest thickness ... ... ... ... ... ... ... ... ... ... ... ... ... | 49 | 42 |
| Greatest length of head ... ... ... ... ... ... ... ... ... ... ... | 65 | 54 |
| Length of tibio-articular tract ... ... ... ... ... ... ... ... ... | 80 | 60 |
| Width of ditto, including eminence ... ... ... ... ... ... ... | 56 | 50 |
| Length of fibular tract ... ... ... ... ... ... ... ... ... ... ... | 40 | 35 |
| Depth in the direction of the calcaneum ... ... ... ... ... | 30 | 30 |

## The Calcaneum.

The calcaneum of *Nototherium tasmanicum* available for study is that of the left foot and the associate of the astragalus which has just been passed in review. It is slightly imperfect, the mutilation relating to the heel portion or non-articular moiety. The articular area of the bone is a doubly facetted surface, with the edges rounded and smoothed into a continuous curved surface, which has nothing akin to the state of things found in the human calcaneum with its three well-marked and restricted articular facets and inferior sinus pedis. The cuboid cup is shallow but well defined, and measures 35 mm. by 25 mm. On the outer or fibular side of the bone about half the floor of the articular tract is cut out by a deep muscular attachment fossa continuous with and forming the lower part of an extensive fossa existing between the tibial facet of the astragalus and its head. This I take to be for the lodgment of the calcaneo-astragaloid ligament. This fossa measures, with both bones in position, 65 mm. long, 25 mm. wide, and at least 25 mm. deep.

The tibial articular tract may be stated to measure 60 mm. by 60 mm., its outline being well depicted in the photograph (Plate 14, Fig. 2).

In its present mutilated condition the bone measures 152 mm. long by 70 mm. wide, and anything up to 20 mm. may be allowed for the missing posterior end.

Upon the whole, the calcaneum of the *Nototherium* is fairly similar to that of the *Diprotodon*, but very much less massive.

## The Pelvis.

A glance at Plate 15 will show that a large portion of the pelvic region is present in our specimen. The ilia are somewhat imperfect along their borders, chiefly in the regions of the anterior spines, while an unfortunate fracture (due to hasty excavation) along the sacral line is reproduced in the photograph. The sacral vertebræ *in situ* are three in number, and possibly a fourth may have been intimately associated with the os innominatum, as in the wombat. Such vertebræ are the only ones which can in strict truth be called "sacral," although it is common to allot seven sacrals to the wombat; the last three, however, are better designated "pre-caudals," or "post-sacrals," in accurate osteology. The ischia are represented by their bodies and tuberosities, their ascending rami being missing. The pubic bones are broken off at their bases or parts of articulation with the ilia and ischia: as it was a fully adult animal, no trace of the original triple union is here manifest (although it often persists rather late in the wombat), all sutures being ankylosed to extinction.

As with *Diprotodon*, so here, the general construction of the pelvis is flat, thin, and spreading, the ilia being true wings, slightly convex outwardly, and inwardly excavated into two round shallow basins. This pelvis in life must have given a flatness to the posterior end of the back similar to that found in the wombat and also reproduced in outline by Dr. Stirling in his restoration of the *Diprotodon*. I shall revert to this subject in my concluding remarks.

The acetabula are two round cups conformable with the extremely well-rounded heads of the femora already noted. Their floors are cut into by two elongated horseshoe-shaped cotyloid fossæ ending outwardly in two cotyloid notches.

The photograph of this fairly complete pelvis, aided by the following table of measurements, should supply material for the identification of such *Nototherian* pelvic fragments as may be recovered in the future.

*Table of Measurements.*

| Nature of the Measurement Made. | Size. |
|---|---|
| | mm. |
| Total width across ilia (not quite perfect) | 702 |
| Greatest width of right ilium (the least mutilated of the two) | 235 |
| Ditto | 161 |
| Length from tuberosity of ischium to superior border of the ilium | 535 |
| Acetabulum (internal size) from upper rim to cotyloid notch | 110 |
| Internal acetabular width | 92 |
| Length of the three sacral vertebræ *in situ* | 175 |
| Transverse measurement of inlet of pelvis | 172 |
| Width of complete pelvis in the regions of the upper rims of the acetabula | 422 |
| Surface of the tuberosity of the least mutilated ischium (slightly imperfect) | 115 |

# The Vertebrae.

In his original descriptions of the bones of *Nototheria*, Owen was restricted to a single specimen of an atlas, or first cervical, and this was the basis of his whole analysis of the vertebræ of these animals. As this bone was figured and described in the "Extinct Mammals of Australia," I gave a comparison of our atlas in my first published notes in the "Tasmanian Naturalist" (Vol. 2, No. 4, April, 1911), deeming such comparative data of interest in connection with the establishment of a new species. The following is the note in question :—

> "The only other bone figured by Professor Owen in illustration of his type of '*Nototherium mitchelli*' is the atlas vertebra, and if this bone is compared with that of *N. tasmanicum*, it will be found that the

latter is rather more depressed than the former, in the proportion of 45 to 57.

| Comparative Vertebræ. | N. mitchelli. | N. tasmanicum. |
|---|---|---|
| | mm. | mm. |
| Width across articular surfaces of neurapophyses ... ... | 112 | 113 |
| Depth from neural spine to a line drawn across the tuberosities (of the unfinished bony ring) ... .. ... | 115 | 91 |

"The osteology is otherwise similar in the several foramina, articular surfaces, and muscular tracts."

On Plate 16 of the present volume the whole cervical series of *Nototherium tasmanicum* is illustrated, the atlas and sixth cervical being turned face outwards and the rest in nearly normal position. As already said, the atlas is more depressed than that of *N. mitchelli*, and both depart considerably from that of the *Diprotodon*. The neck vertebræ as a whole are short, and incapable of anything like the amount of vertical movement found in the modern grazing animals—suggesting, indeed, the upward cropping of leaves and twigs of low trees, or the lower gathering of the leaves and shoots of shrubby plants. The axis vertebra is worthy of special note, being provided with a neural spine of an absolutely distinctive character. The *Diprotodon*, as carefully built up in this region by Messrs. Zietz and Stirling, shows that the second cervical spine of that animal was an enlarged replica of that of the wombat. If this wombat type of axis were assumed by any palæontologist to apply to the whole group of these extinct animals, the second cervical of *N. tasmanicum* would certainly be listed as missing by a worker who looked at an articulated block of cervicals (through the medium of a photograph). To prevent such an assumption the photograph is arranged to show the odontoid process, thus setting at rest the question of its correct determination, and demonstrating once and for all the structural departure made by this cervical from the wombat and *Diprotodon* model. As in the *Diprotodon*, so here, the body of the axis is elongated, but otherwise the two vertebræ have little in common. This photograph of the cervicals is so good that an extended description is unnecessary, but a table of measurements is given for the purpose of identification of fragments. It must, however, be pointed out that the last (or left-hand) three vertebræ were unfortunately misplaced by the photographer in arranging the picture, the result being that the sixth cervical is turned face outwards, instead of the seventh, as was of course intended, and the real seventh appears as the fifth. The failure to accurately articulate is evident in the left-hand two of the main block of five. The variation in the robustness of the apices of the neural spines should be as follows:—Cervical No. 2, maximum; 3, 4, and 5 tending to a minimum which is reached in 6; cervical 7 again presenting a wide neural spine at the end of the series.

As the axis vertebra is of unusual interest, a short account of its structure and departures from the normal *Diprotodon* type may be acceptable. When placed upon its posterior centrum, with the odontoid process standing vertically, the centrum appears to be roofed by the two articular surfaces set like a double penthouse at an angle of 45 degrees. Above them like a ridge-cap rises the odontoid process, measuring 20 mm. high and 20 mm. in diameter. Leading downwards from the base of the process is an elevated track some 5 mm. wide, which bifurcates and expands on either side of the lower anterior body of the vertebra, thus forming two divergent valleys, the anterior walls of which are the articular surfaces themselves. Two similar but less pronounced valleys cross the posterior half of the body of the vertebra, leading away to the back of the two stunted piers, which in later vertebræ join with the processes to form the vertebrarterial canal. On the upper or neural surface the odontoid extends forward into the atlas for a distance of 30 mm., ending posteriorly in an abrupt manner against the condylar articular surfaces. Two foramina here penetrate the body of the vertebra. The odontoid at its base or junction with the articular surfaces rises by a step 10 mm. high to continue into the neural canal as a raised tract of 20 mm. wide. (This I consider is unquestionably part of the odontoid, regarded in the light of the homologue of the centrum of the atlas.) This tract continues through the neural canal, but after a course of 25 mm. in length contracts to a narrow trabecula of bone 4 mm. wide which overspans a deeply excavated foramen, penetrating the body of the bone to a vertical depth of 22 mm. This amount of superossification indicates the activity of the old ossific centre of the disjointed atlas centrum, and therefore the lowly character of the animal under consideration. The odontoid process and the upward step of the process into the neural canal can be seen in the photograph, as also a pointed process in the anterior line of the neural spine. During normal vertebral articulation the aborted spine of the atlas worked against this point in the axis, both being flattened and roughened as if for a loose kind of syndesmosial union. The posterior centrum is approximately oval in outline, with the lower and upper sides slightly bulging. The essential characteristics of these cervical vertebræ are their flat (cetacean-like) centra and wide neural canals, evidently fitting the animal for side to side, neck and head motion, rather than for any vertical range of movement.

## The Remainder of the Skeleton.

If we include the cervicals just reviewed, the complete series of vertebræ between the skull and the ankylosed sacrals available for study in our specimen amounts to 19. This I estimate to be at least six short of the correct number. Plate 17 is arranged to depict the characters of the dorsal and lumbar vertebræ, while Plate 18 illustrates the four post-sacrals and the first true caudal vertebræ.

The ribs recovered with the other remains of our animal amount to 14 pairs, which must be very close to the full series. Hereunder is a complete table of measurements relating to the cervical series of vertebræ.

*Table of Measurements of the Cervical Series of Vertebræ of Nototherium Tasmanicum.*

| Name. | Height. | Width. | Thickness. | Articular Diameter of Anterior Centrum. | Height of Spine. | Height of Neural Canal—Anterior. | Width of Neural Canal Anterior. | Across Rims of Articular Cups of Atlas. | Greatest Length of Transverse Processes. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| Atlas | 95 mm. | Of unmutilated half, 115 mm. | 77 mm. | No centrum | None | 58 mm. | Approximately 56 mm. | 113 | 70 mm. | Homologue of atlas centrum, the odontoid process. For comparison with atlas of N. mitchelli, see text |
| Atlas | 157 mm. | 126 mm. | Including the odontoid, 109 mm. | 95 mm. x 40 mm. | 90 mm. | 20 mm. | 40 mm | Vertebrarterial foramen, none | 40 mm. | Neural spine unlike that of Diprotodon, see text |
| Cervical three | 150 mm. | 140 mm. | Including processes, 77 mm. | 64 mm. x 49 mm. | 80 mm. | 21 mm. | 46 mm. | Vertebrarterial foramen, 15 mm. x 15 mm. | 39 mm | First complete vertebrarterial foramen |
| Cervical four | Spine rather imperfect. 140 mm. | Perfect half, 80 mm.; total, approximately 160 mm. | 77 mm. | 70 mm. x 50 mm. | Slightly imperfect 72 mm. | 22 mm. | 47 mm. | 15 mm. x 14 mm. | 50 mm. | Upper part of the neural spine rubbed |
| Cervical five | Lower centrum imperfect; approximately 133 mm. | 164 mm. | 69 mm. | Slightly imperfect, 74 x (?) | Imperfect; approximately 65 mm. | 25 mm. | 55 mm. | 15 mm. x 15 mm. | 54 mm. | Lower edge of the centrum missing |
| Cervical six | Spine & centrum imperfect; approximately 134 mm. | 160 mm. | 62 mm. | Imperfect, 73 mm. x (?) | Slightly imperfect; approximately 60 mm. | 31 mm. | 58 mm. | 13 mm. x 15 mm. | 50 mm. | Both the apex of the spine and the lower edge of the centrum imperfect |
| Cervical seven | Spine & centrum imperfect; approximately 140 mm. | 170 mm. | 62 mm. | Imperfect, 72 mm. x (?) | 61 mm. | 35 mm. | 60 mm. | 9 mm. x 7 mm. | 45 mm | Spine and centrum imperfect |

# History and Bibliography.

Owing to the fact that the discoveries of *Nototherian* remains have been relatively few, the genus has a less extensive bibliography than usually obtains among extinct mammals. The only synonym which can be associated with the generic designation is that of "*Zygomaturus*" given originally (in a half-popular way) by Macleay to some *Nototherian* remains, subsequently partly withdrawn and later resuscitated by De Vis as being a good and true genus. This question is still unsettled, but recapitulatory of the present text I may say that, as the Western Australian teeth, those of *N. victoriæ* from King Island, and teeth of *Zygomaturus* are all very closely allied, and *N. victoriæ* seems to have been a female animal, the mystery of *Zygomaturus* is possibly bound up in characters of sex, and not those of generic or specific taxonomy.

Instead of re-listing the bibliographical notes of Lydekker ([19]), R. Etheridge ([20]), and Flower and Garson ([21]), I propose to outline the more important historical facts relating to the *Nototheria*, with special reference to such discoveries as have been referred to in the present memoir. This, of course, does not comprise all discoveries of *Nototheria*, and must be regarded solely in the light of a practical and strictly utilitarian digest.

*History of the Genus Nototherium.*

| | |
|---|---|
| First specimens found by Col. Sir T. Mitchell, C.B., and presented to the Royal College of Surgeons. Locality of the discovery, Condamine River, Queensland ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 1842 |
| The above bones described by Professor R. Owen in the Report of the British Association for 1844 and 1845, page 231. [Two species were founded, viz., (1) *Nototherium mitchelli*, and (2) *Nototherium inerme*.] | 1844 and 1845 |
| *Nototherium victoriæ* found in the Pleistocene strata of Lake Victoria, in South Australia, and described by Professor R. Owen in the Philosophical Transactions for 1872, Plates 7 and 10, Figs. 4 and 6. [Reprinted in 1877 in "Extinct Mammals of Australia," Plates XLI. and XLIV., Figs. 4 to 6.] ... ... ... ... ... ... ... ... ... ... ... ... ... ... | 1872 |

([19]) Cat. Foss. Mamm. Brit. Mus., Vol. 5.

([20]) "Palæontology of Queensland," Jack and Etheridge, page 667.

([21]) Cat. Ost. Specimens (Part 2, Mammals), Roy. Coll. Surg., Flower and Garson.

Symphysis of jaw of *N. mitchelli* found in Queensland, and figured and described by Professor R. Owen in Philosophical Transactions for 1872, Plate 5 (reproduced in "Extinct Mammals of Australia," Plate XXXIX.). [This jaw is the one noted in my present text as having a less extensive symphysis than *Nototherium tasmanicum.*] ... ... ... 1872

Type humerus of *N. mitchelli* found near Mendoran, River Kirban, New South Wales, and presented by Mr. W. L. R. Gipps to the British Museum in 1875. Figured by Professor Owen in his "Extinct Mammals of Australia," Plate CXXVII. [An outline of this is given by me on Plate 6 for comparison with the humerus of *N. tasmanicum.*] 1875 to 1877

Distal end of type femur of *Nototherium mitchelli* found in Queensland, and, being of relative size to the preceding, was relegated to *N. mitchelli* by Professor Owen (see Quart. Journ. Geolog. Soc., Vol. XXXVIII., Plate XVI.). [This bone is shown (in section) on Plate 12 of the present text in contrast with that of *N. tasmanicum* and that of a *Diprotodon.*] ... ... ... ... ... ... ... ... ... ... ... ... ... 1877

Establishment of the species *Nototherium dunense* by De Vis. (Pro. Linn. Soc. New South Wales, 1887 (2), Part 4, page 1065, t. 30. Also, De Vis, Pro. Roy. Soc. Queensland, 1888, V., Part 3, page 116, Plate 2, central fig.) Species founded on a mandibular fragment and a left adult mandible. Species accepted by Jack and Etheridge in "Geology and Palæontology of Queensland" ... ... ... ... ... ... ... 1887

Publication of R. Lydekker's "Catalogue of the Fossil Mammals in the British Museum," in Vol. V. of which he admits one species of *Nototherium* only, namely, *N. mitchelli*, this being regarded as the type ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 1887

Discovery of *Nototherian* remains at Smithton, North-Western Tasmania, in August, 1910. These were first described in the "Tasmanian Naturalist" (April, 1911), under the name of *Nototherium tasmanicum*, the species depending upon the departures made by the humerus and femur from the type *N. mitchelli*, also upon the elongated nasal regions, the longer mandibular symphysis, and the shorter tooth-line. 1910 to 1911

"The Occurrence of Gigantic Marsupials in Tasmania," Royal Society, Nov. 14, 1911, by Fritz Noetling, M.A., Ph.D.) ... ... ... ... ... ... ... 1911

Discovery of *Nototherian* teeth in Western Australia, and the publication of description of the same by L. Glauert, F.G.S., in the Records of the Western Australian Museum, Vol. 1, Part 2. [These are the teeth referred to in my analysis of the teeth of *N. tasmanicum.*] ... ... ... 1912

Discovery of remains of *Nototherium victoriæ* on King Island by Mr. F. H. Stephenson in February, 1912. [These are the teeth noted in the present text, and also in the Victoria Museum Memoir No. 4 next recorded] .. ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 1912

Publication of Victoria Museum Memoir No. 4, containing some extended notes upon *N. tasmanicum*, and recording the discovery of *N. victoriæ* upon King Island in August, 1912 ... ... ... ... ... ... ... ... ... 1912

Notes on *N. tasmanicum* and the evidence in favour of the existence of a short trunk in *Nototherium*, submitted through Professor T. W. Edgeworth David to the Melbourne meeting of the Australasian Association for the Advancement of Science in January, 1913 ... ... 1913

The completion of the present monograph on the two species of *Nototherium* in March, 1914 ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 1914

# Concluding Remarks.

If we could turn back the page of recent geology to Pleistocene time, and gaze in upon the *Nototheria* as they trampled through the forest edges, glades, and marshes, what kind of creatures should we behold? Heavy and elephantine to some extent, with nearly straight fore-legs, but capable of rearing themselves up against the boles of forest trees as modern elephants sometimes do, while their flexible snouts and drag-hook like tusks garnered the juicy shoots and tender leaves which served as food. Their powerful molar teeth were suited for grinding up the nutrient twigs as well as the leaves, and in bad times the latter possibly formed the lion's share of their provender. As dry seasons drove them from the older haunts of plenty to zones of hardy shrubby plants, or as they slowly advanced lakewards, they doubtless took toll of such scrubby bushes as they encountered, and in the final reckoning of their race these formed the last staple of their food. They were largely nocturnal, I should imagine, resting much in hollow banks and shady places during the hours of brilliant sunlight, or at best leisurely cropping in the darker recesses of the heavy scrub. We may picture them at night tramping down to water-holes, tarns, and marshes, to splash in the cool water and rid themselves of pestilential diptera and other insects. Here at times they became mired and bogged, particularly as the physiography of the country changed with geological alterations of level, and they became compelled to haunt more frequently

the better watered spots. In Australia these last mustering grounds of the larger vegetable-eating marsupials became their graves, as has been demonstrated by Dr. Stirling and Mr. Zietz in the case of Lake Callabonna, their last meals of semi-desert plants having been discovered associated with their remains. These plants had braved the dire change of climate to the last, and held local sway when the last *Diprotodon* had died from thirst and starvation. The whole story of their extinction cannot be known; climatic changes must have been very potent factors, but other unknown causes must have assisted in Tasmania, if ever these creatures secured a footing in the country, since the slowly-forming desert lands of the wider Australian areas were here absent. Like the elephants of to-day, the *Nototheria* combined within their frames both generalised and specialised characters; that great upbending of the nasal and basi-cranial regions is unique, although *Phascolarctus* and *Phascolonus* partly share it. The native bear character of the lower tusks operating in the grooved lateral incisors of the upper jaw, and the similarity in humeri and scapulæ, of these two animals coexist with many wombat characters.

Professor Frederick McCoy, of the Melbourne University, suggested in 1877 that the *Nototheria* in their habits were homoplastically the ground sloths of Australia. Some such idea occurred to me when I was unaware of this expression of opinion, but later studies led me to relinquish it, and to regard these creatures as tapir-like marsupials, furnished with a flexible snout, if not a short tapir-like trunk. The evidence on this subject is detailed below. During the visit of the British Association for the Advancement of Science to Australia, Professor Watson examined our *Nototherian* remains, checked my notes, and expressed the following opinion :—

(1) That the animals in life had noses not much more extended than that of the native bear.

(2) That the nasal bosses supported a hard horny substance, which might or might not have been prolonged into horns : they were probably used for fighting.

(3) That various nutrient grooves and foramina in the nasal regions relate to these incipient horns, while certain roughened surfaces regarded as being of myological import by myself are really the results of old wounds followed by severe inflammation.

This view of the case would place the *Nototherium* nearer to the rhinoceros, or perhaps, in appearance, to the accepted restoration of the American *Brontops* type of head, although the latter manifests distinct horn-cores, which the *Nototherium* does not—a fact, no doubt, appreciated by Professor Watson, as may be inferred from his contention that the horns or bosses need not have been prolonged.

The evidence which I should adduce in favour of a movable nose or snout would be as follows :—

In the nearest living congener of the *Nototherium*, namely the native bear, the tusks and lateral incisors manifest a pre-alveolar extension which precedes the actual gum-line, thus indicating a heavy, fleshy lip. This lip in the living animal is prolonged into a pointed snout or incipient trunk, but as a real trunk would be useless, is not farther extended. Such being the case, the nasal bones of the skull are kept inside the maxillary moieties which contribute walls to the nasal cavity. Had, therefore, a trunk existed in this animal, any attempt at strongly pulling it downwards would have driven the nasal bones into the nasal cavity. In the extinct *Nototherium*, however, the nasal bones are specially supported by two powerful exogenous outgrowths of the maxillary—obviously to resist great strain either in tearing off foliage, or, according to Professor Watson's view, to support the nasal horns. To a *Nototherium* the possession of a trunk would have been a distinct desideratum, as it would have assisted the animal in gathering its food when the head was elevated, or, as its neck was capable of little flexion, when cropping close to the ground.

*Evidence in Favour of a Short Trunk.*

The evidence in favour of a short trunk is as follows :—

(1) General shape of the skull.

(2) Nasals specially under-propped to support the powerful retractor rostri muscles and act as a fulcrum thereto.

(3) Nasal regions of skull practically unique among marsupials, though partly shared by the pointed-nosed native bear, and in a lesser degree by the wombat, thus forming stages from and towards a movable nose.

(4) Fronto-nasal regions excavated by a deep transverse fossa, most likely for the reception of air sinuses and partly the rostral muscles. (Note.—This fossa has no explanation in the view expressed by Professor Watson.)

(5) Forehead scarred as for the reception of off-shoots of the retractor rostri muscle, as in the Indian tapir.

(6) Pre-alveolar extension of the teeth to give lodgment to a fleshy inner lip incidental to an incipient trunk.

(7) Pre-orbital foramen large, so as to supply the needful nerves for such an extended nasal region.

(8) Orbital region of the skull very heavy, to give attachment to zygomatic and lachrymal branches of the trunk muscles.

(9) A fleshy lip no longer than that existing in the native bear would not account for the above osteology and myology of the skull.

(10) The nasal bones among marsupials expand as they go backwards; the reverse obtains in the *Nototherium* skull: this is consistent with the possession either of a movable nose or of one armed with horns.

On the opposite assumption, the evidence on which I have relied in support of an extended nasal cartilage would probably be referred to the effects of inflammation or osteonecrosis. The close association of the stunted spine of the atlas vertebra with a process in the neural spine of the axis, and the obvious friction of these against one another, suggest a fairly common, if not constant, habit of cropping face upwards and of rolling the head from side to side. Professor Watson agrees in this statement also.

### *The Characters of Sex.*

As already hinted, I conclude that *Nototherium victoriæ* was a female animal on account of its weak tusks and their shallow alveoli, and therefore assume that the characters upon which the species was founded are those of sex, and not due to specific segregation. On the other hand, Professor Watson regards the variation of the astragalus as being almost sufficiently marked to constitute a taxonomic character. Only a large series of bones can settle such a point. As a working hypothesis, however, I suggest that all animals with flat, weak tusks, posterior rami of the mandible with dental outlets at or near the tooth-line and with dental characters such as in the present text are recorded for *Nototherium victoriæ*, be regarded as females.

*Nototherium inerme* of Owen was, I think, a young female; hence the possibility of the obliteration of the alveoli of the tusks by grinding (post-mortem) as suggested by Professor Flower. This suggestion could not well apply to a young male, as the alveoli would be far too deep.

### *The Argument as to a New Species.*

As matters stand, the correctness or incorrectness of the relegation of the humerus and femur by Owen to *Nototherium mitchelli* largely determines the acceptance or otherwise of my species *tasmanicum* as originally described. Professor Watson, who has an extensive knowledge of the British Museum collection

of *Nototherian* remains, considers our skeleton unquestionably represents a new species. A recently received cast of the skull of *N. mitchelli*, as actually used by Owen for descriptive purposes, is exhibited in our Museum beside the actual skull of *N. tasmanicum*, and manifests many points of dissimilarity.([22]) These several departures exist after all allowance has been made for mistakes incidental to restoration, several of which can be detected. In Owen's cast the parietals meet upon the vertex after the formation of a flat surface similar to that existing in the skull of wombats. In our specimen the parietals are extremely compressed and reduced at their meeting place to a few millimetres in width. This is a natural line of calvarial termination gradually formed out of their total ascending contour, and not a muscular, superimposed parietal crest. Professor Watson informs me that the flat vertex is correct for skulls in the British Museum collection. As to the vexed question of the limb bones, I content myself with the expression of my personal opinion. In 1870 Owen described and depicted in the "Philosophical Transactions" ([23]) a femur and a humerus very similar to those which we now know to have been possessed by the *Nototheria*, the humerus, however, being devoid of an entepicondylar foramen. These remains, I take it, are still assigned to *Diprotodon*. In 1877, in his great work upon the extinct mammals of Australia, he described and depicted a humerus for *Nototherium mitchelli*. This was illustrated very fully by four figures ([24]), one of which I have reproduced in contrast with the humerus of *N. tasmanicum*. This humerus was one either of *Phascolonus gigas* or of some similar extinct wombat as yet unaccounted for. The departures made by a *Phascolonian* humerus from that of *Diprotodon* served the purposes of taxonomy, and separated widely *Diprotodon* from *Nototherium*. The future may show that these animals were pretty closely allied, and that, irrespective of size and weight, the *Diprotodon* humerus departs most from that of *Nototherium* in the absence of an entepicondylar foramen, in having a straighter shaft (if Owen's figure is correct) and in a rearrangement of muscular crests and asperities. Or it may prove that two races of *Nototheria* existed, one with humeri approaching the *Diprotodon* type and another approximating to the wombat type. In either case, our skeleton will form a true court of appeal, as all its bones are associates, that is to say, parts of the skeleton of a single individual.

I feel convinced, however, that two species will eventually be admitted even on the evidence of the skulls alone, one of which shows a platyrhine species (*Nototherium mitchelli*), and the other a more or less latifrons one (*Nototherium tasmanicum*). The characters used under similar designations in the classification of existing wombats can be seen by the evidence presented in this monograph to have much in common with those of these two species.

([22]) This cast arrived after the notes upon our skull were drawn up.

([23]) Foss. Mamm. Aust., Phil. Trans., Part 3, pages 519 to 578, Plates 36-38.

([24]) "Extinct Mammals of Australia," Plate 127.

The possibility of *Phascolonian* bones being mistaken for those of *Nototheria* did not escape Professor Owen himself, hence the following: "I have described in former works some detached bones which from their size might, and probably do, belong to the genus *Nototherium*; but I have since received evidence of an extinct species of nearly equal size, and more akin to the wombat and kangaroo families, to which some of the fossil limb bones from *Nototherian* localities might possibly belong." (*Vide* "The Fossil Mammals of Australia," Part V., Genus *Nototherium*, page 78, 1871.)

## Restoration of Nototherium Tasmanicum.

In a former paper, published in the Museum series of memoirs, an attempt was made to give a conjectural restoration of the outline of a *Nototherium*. This sketch ran purely upon the wombat type of animal, and did not fully express the elongated fore-quarters or the enormous dilation of the nasal regions. The present sketch is the work of Mr. Victor Henry, who has spent much time and pains in the thankless task of trying to cover these dry bones with the tissues of life. It is by no means certain to my mind that the outline of the face of a *Nototherium* actually followed the incurving of the facial bones; indeed, it seems likely that cartilaginous air sinuses similar to those found in tapirs, or cheek pouches as in *Phascolarctus*, may have filled up the sides of the nose. These would have reduced the effect of the exaggerated lateral dilatation of the actual nasal bones. In assuming the existence of a mobile snout in the *Nototherium*, the expressed objection is encountered that the nasal bones in all trunk-bearing animals recede upon the skull. This, upon the whole, is true, but there are various grades upon both sides. In the elephant and *Dinotherium* we reach a maximum in this respect, while in the *Megatherium* and some tapirs we get upon the descending scale. In the extinct tapir-like animal *Palæosyops* the nasals reach the line of the pre-maxillaries, and yet that animal is usually restored with a full tapir-like trunk. The living herbivora with flexible lips and no trunks have nasal bones which recede considerably upon the skull (70 mm. by actual measurement in a male Bos banteng lowii of Borneo).

Thus we get *Palæosyops* with elongated nasals and a trunk and many herbivora with receding nasals and no trunk. In all these latter cases, however, the nasal bones are weak and devoid of any underpropping supports, and are therefore withdrawn from the point forming the fulcrum of muscular strain. In the *Nototheria* the powerfully supported nasals were the chief strain-bearers for either the fighting bones (as suggested by Professor Watson) or the incipient trunk

of the present restoration. It might well have been that both obtained, but the horny knobs have not been added to Mr. Henry's sketch. A careful examination of the osseous tissue of the nasal bones of the *Nototherium* shows a similar condition to that found upon a smaller scale in the bones surrounding the nasal cavity of the native bear (here chiefly the pre-maxillaries) upon those parts which underlie the naked nose. This, taken in conjunction with the other osteological characters cited, suggests in the larger animal an exaggerated and relatively much more powerful snout with the superadded character of mobility. But, briefly, the face of a *Nototherium* presents to the would-be restorer a chain of endless difficulties, and any criticism of our tentative efforts should in common justice take toll of them. As long ago as 1871 Professor Owen summed up the results of his studies in the following words: "If, as in the skulls of mammals generally, we regard the part anterior to the orbits as the facial division, which is often the longest, the corresponding part in *Nototherium* offers the strangest and most anomalous form and proportions in the mammalian class. It looks like a mere appendage to the skull."(25) This is exactly what we have felt, and our efforts have been directed towards the most likely solution of the problem. It may well have been that the animal in life presented a facial appearance that was almost a satire upon our preconceived notions of animal physiognomy. The nearly vertical bony septum, compounded out of the premaxillary bones, is no greater departure from the marsupial type than the elongated and ossified mesethmoid (found in the skull of *Tapirus bairdii*) is from the common tapir type of nostril, and accordingly has not been found a difficulty in the present restoration. A conjectural outline of a *Nototherium* upon the lines of a wombat presents no special difficulties, as instanced by our own attempts already published, but it evades many important points, and cannot therefore be even approximately correct. In life a *Nototherium* must have differed more in appearance from a wombat than the existing native bear does from the ring-tailed phalanger. The giant wombat (*Phascolonus*) was a titanic wombat pure and simple, and would have looked such, while the *Nototherium* was the most quaint-looking marsupial that ever lived. An examination of Plate 19 will show the extent to which an outline of the skull lends itself to the suggestion of a mobile snout, while an attentive study of the restoration will reveal suggestions of the wombat and native bear, together with a blending of the superimposed taperoid characters consistent with its method of life.

(25) "The Fossil Mammals of Australia," by R. Owen, Phil. Trans., June 15, 1871, Part 4, page 48.

# Plates and Explanations.

## PLATE 1.

Skull of *Nototherium tasmanicum* (sp. nov.). Length 551 mm.

# PLATE 2.

*Left-hand Figure.*

Mandible of *Nototherium tasmanicum* (prior to restoration) showing extent of symphysis and teeth *in situ*.

*Right-hand Figure.*

Mandible of *Nototherium tasmanicum* showing roots of tusks and outside aspect of right-hand tooth-line.

Length of specimens, 375 mm.

*Left-hand Figure*

*Right-hand Figure*

# PLATE 3.

Coronoid process, last two molars, and part of the left ramus of the mandible of *Nototherium tasmanicum*. The arrow points to the mandibular dental foramen. Contrast with that of *Nototherium victoriæ* (Plate 4). Width of specimen, right to left, 218 mm.

# PLATE 4.

*Fig. 1.*

Coronoid end of left ramus of the mandible of *Nototherium victoriæ*, Owen. Molar No. 4 *in situ*. The arrow points to the position of the mandibular foramen. Width of specimen, 255 mm.

*Fig. 2.*

Right pre-molars, 1, 2, 3, of *Nototherium victoriæ in situ*.

2
1

# PLATE 5.

Comparative humeri of Elephants (after Leith Adams):

*Palæomastodon* (Fig. 1).

*Elephas primigenius* (Fig. 2).

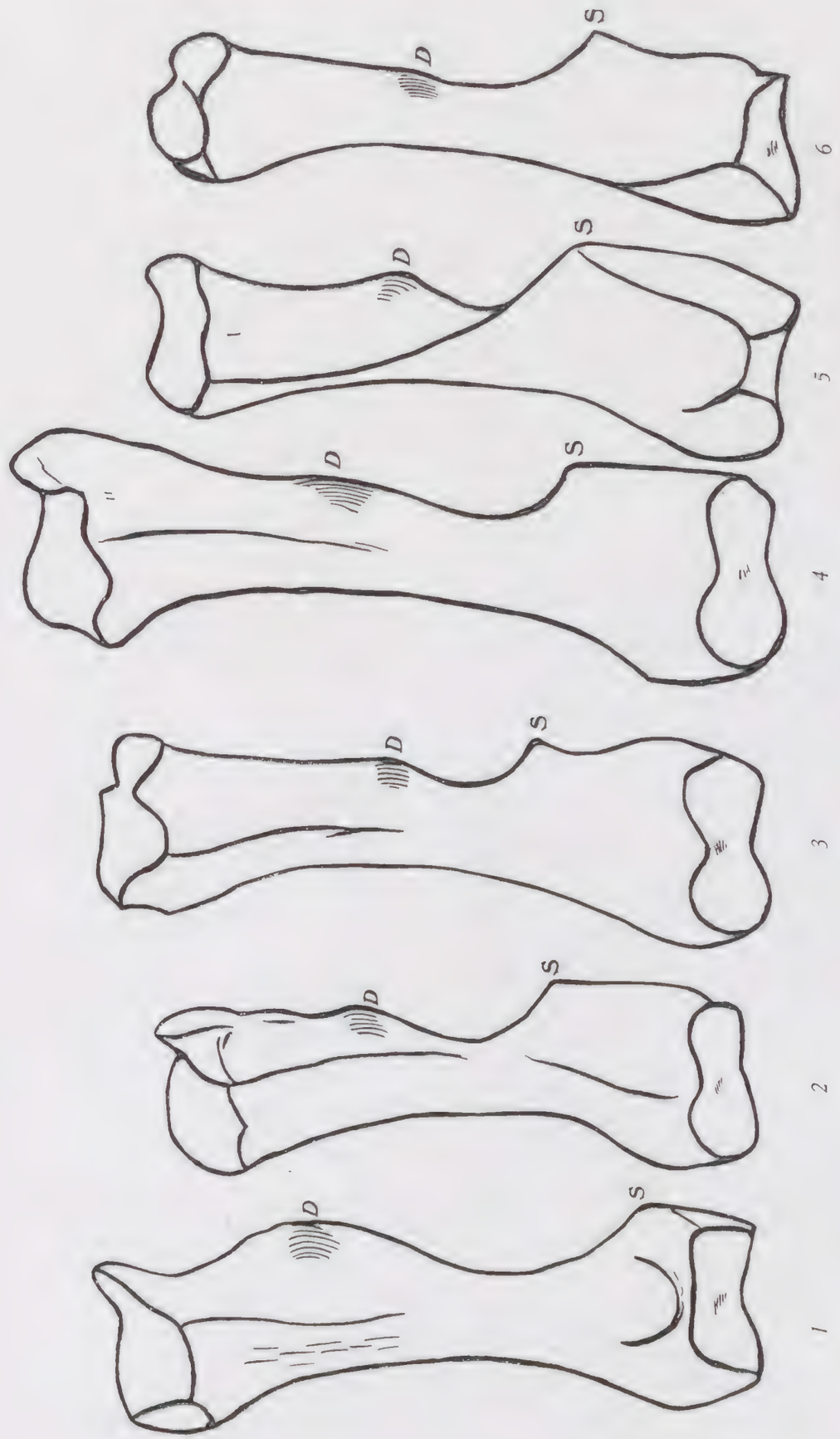
*Elephas meridionalis* (Fig. 3).

*Elephas antiquus* (Fig. 4).

*Elephas asiaticus* (Fig. 5).

*Elephas africanus* (Fig. 6).

*d* = deltoid. *s* = supinator.


D
S
1
2
3
4
5
6

# PLATE 6.

*Fig. 1.*

Humerus of *Nototherium mitchelli* (from Owen's "Extinct Mammals of Australia," Plate 127), half-size. Thenal view. Total length, 400 mm.

*Fig. 2.*

Humerus of *Nototherium tasmanicum*. Thenal view. Total length, 460 mm.

1

2

# PLATE 7.

*Left-hand Figure.*

Thenal view of humerus of *Nototherium tasmanicum.*

*Right-hand Figure.*

Anconal view of humerus of *Nototherium tasmanicum.*

Length of specimen, 467 mm.

*Left-hand Figure*

*Right-hand Figure*

# PLATE 8.

*Left-hand Figure.*

Ulnar view of the humerus of *Nototherium tasmanicum.*

*Right-hand Figure.*

Radial view of the humerus of *Nototherium tasmanicum.*

Length of specimen, 467 mm.

*Left-hand Figure*

*Right-hand Figure*

# PLATE 9.

Scapulæ of Nototherium Tasmanicum.

*Fig. 1.*

Right scapula arranged to show pre-scapular edge. The arrow at "A" touches the pre-scapular prominence.

*Fig. 2.*

Left scapula, showing post-scapular edge and curious distal transverse post-scapular groove or fossa touched by the arrow "B."

Height of specimen, 430 mm.

B
2
A
1

# PLATE 10.

*Fig. 1.*

Proximal end of radius of *Nototherium tasmanicum*.

*Figs. 2 and 3.*

Two clavicles, one imperfect, of *Nototherium tasmanicum*.

*Fig. 4.*

Proximal end of ulna of *Nototherium tasmanicum*. Length, 343 mm.

*1* *2 and 3* *4*

# PLATE 11.

Femur of *Nototherium tasmanicum*. The arrow touches the shaft at the height of 216 mm. "Owen's line." Length, 475 mm.

# PLATE 12.

Sectional outline of shaft of femur of *Nototherium tasmanicum*. Full size.

Sectional outline of femur of *Nototherium mitchelli*. Half-size. Professor Owen's type specimen.

Sectional outline of shaft of femur of *Diprotodon*, sp. Specimen from Darling Downs. Full size.

# Comparative Femora.

SECTIONAL OUTLINE OF SHAFT OF FEMUR OF "NOTOTHERIUM TASMANICUM." (FULL SIZE.)

SECTIONAL OUTLINE OF FEMUR OF "NOTOTHERIUM MITCHELLI." (HALF-SIZE.)
(PROFESSOR OWENS' TYPE SPECIMEN.)

SECTIONAL OUTLINE OF SHAFT OF FEMUR OF DIPROTODON. SP. (SPECIMEN FROM DARLING DOWNS.) (FULL SIZE.)

# PLATE 13.

*Figs. 1, 2, 3, 4.*

Tibiæ and fibulæ of *Nototherium tasmanicum*. Fig. 2 is the left tibia, external aspect, slightly rotated to bring the fibular articular facet to the front. Fig. 3 is the right tibia, external aspect, showing external condyle and bony tubercle in the region of the fibular articulation. Length of specimens, 284 mm.

4
3
2
1

# PLATE 14.

*Fig. 1*

Astragalus of *Nototherium victoriæ*. Tibial surface.

*Fig. 2.*

Calcaneum of *Nototherium tasmanicum*.

*Fig. 3.*

Astragalus of *Nototherium tasmanicum*. Width, 100 mm.

3
2
1

# PLATE 15.

Pelvis and sacrum of *Nototherium tasmanicum*. Width of specimen, 702 mm.

# PLATE 16.

*Figs. 1 and 7.*

Cervical series of vertebræ of *Nototherium tasmanicum*. Length of specimens, 565 mm.

1
2
3
4
7
5
6

# PLATE 17.

*Figs. 1, 2, 3.*

Dorsal vertebræ of *Nototherium tasmanicum*.

*Figs. 4, 5, 6, 7.*

Lumbar vertebræ of *Nototherium tasmanicum*. Length of specimens, 455 mm.

1
2
3
4
5
6
7

# PLATE 18.

Four post-sacrals of the first anterior caudal vertebræ of *Nototherium tasmanicum*. Length, 260 mm.

# PLATE 19.

Skull with outline of restoration of head of *Nototherium tasmanicum* (cervical region diagrammatic).

Length, 551 mm.

## PLATE 20.

Conjectural restoration of the extinct gigantic tapir-like marsupial, *Nototherium tasmanicum*. Approximate size, 9 feet long, 5 feet high, and nearly 3 feet across the hips. Sketch by Mr. Victor Henry.

# PLATE 21.

A phascolomyform femur from the Buchan Cave, Gippsland, Victoria. Contrast with femur of *Nototherium tasmanicum* (Plate 11).

# PLATE 22.

*Fig. 1.*

Outline of skull of *Nototherium tasmanicum*.

*Fig. 2.*

Outline of skull of *Nototherium mitchelli*.

Fig I

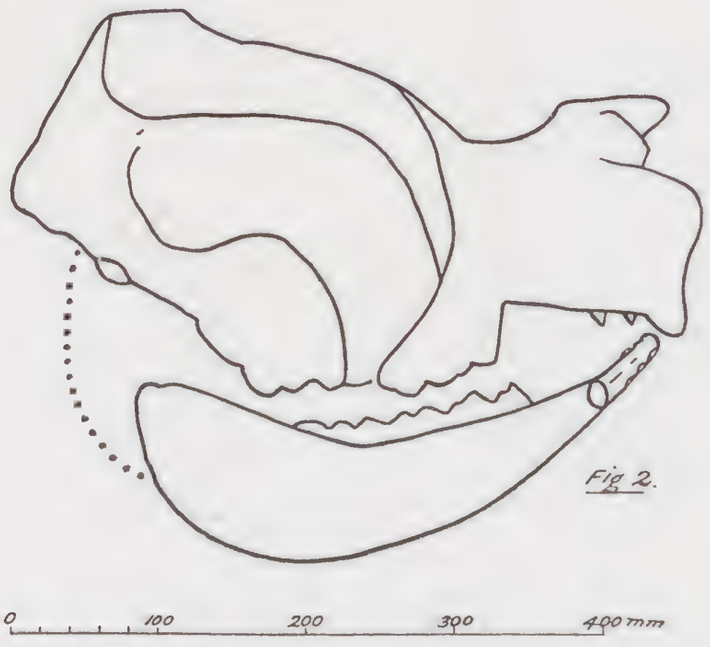



Fig 2.

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